BRUARY, 1948 TECHNOLOGY DEPARTMENT TWO SHILLINGS

Plastics

LING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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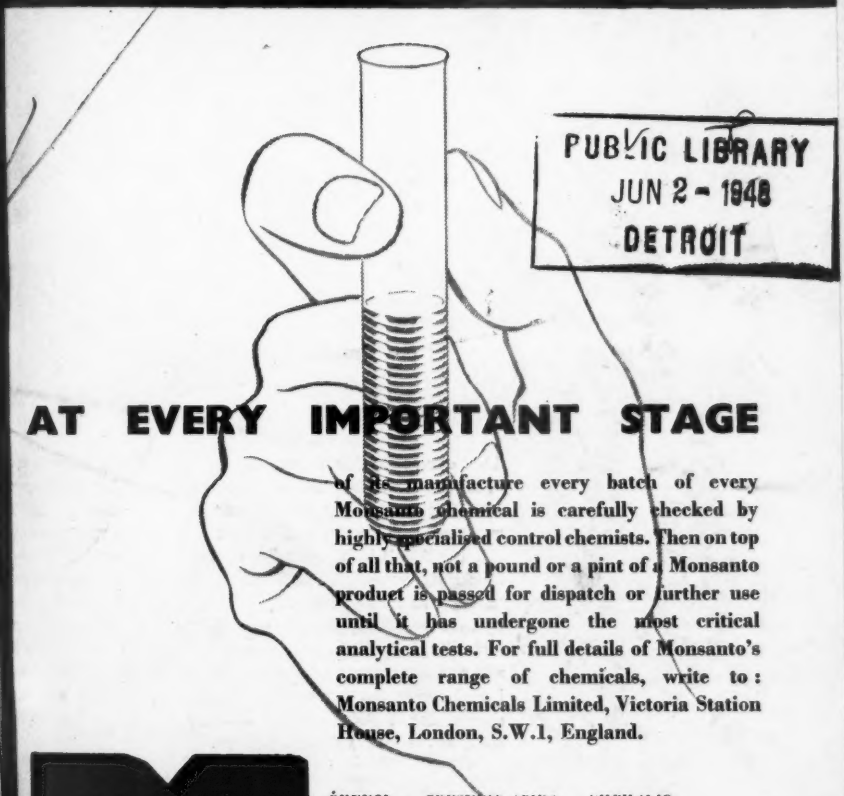

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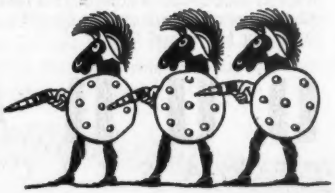

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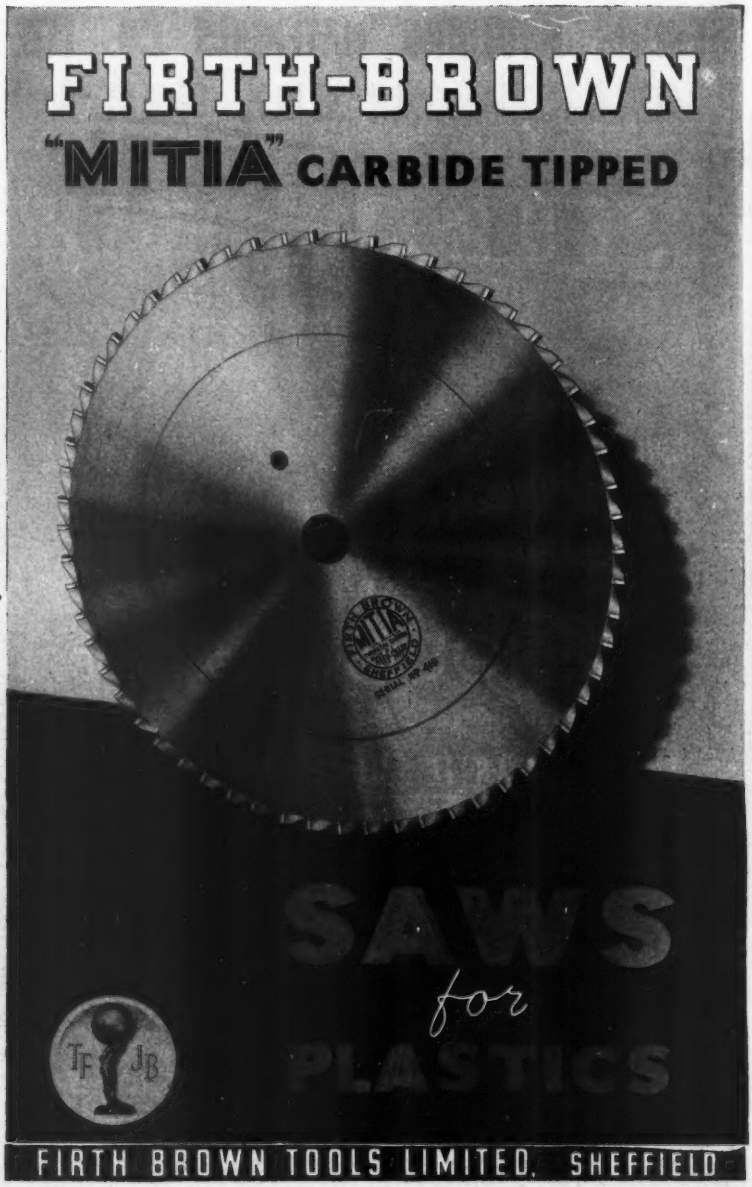
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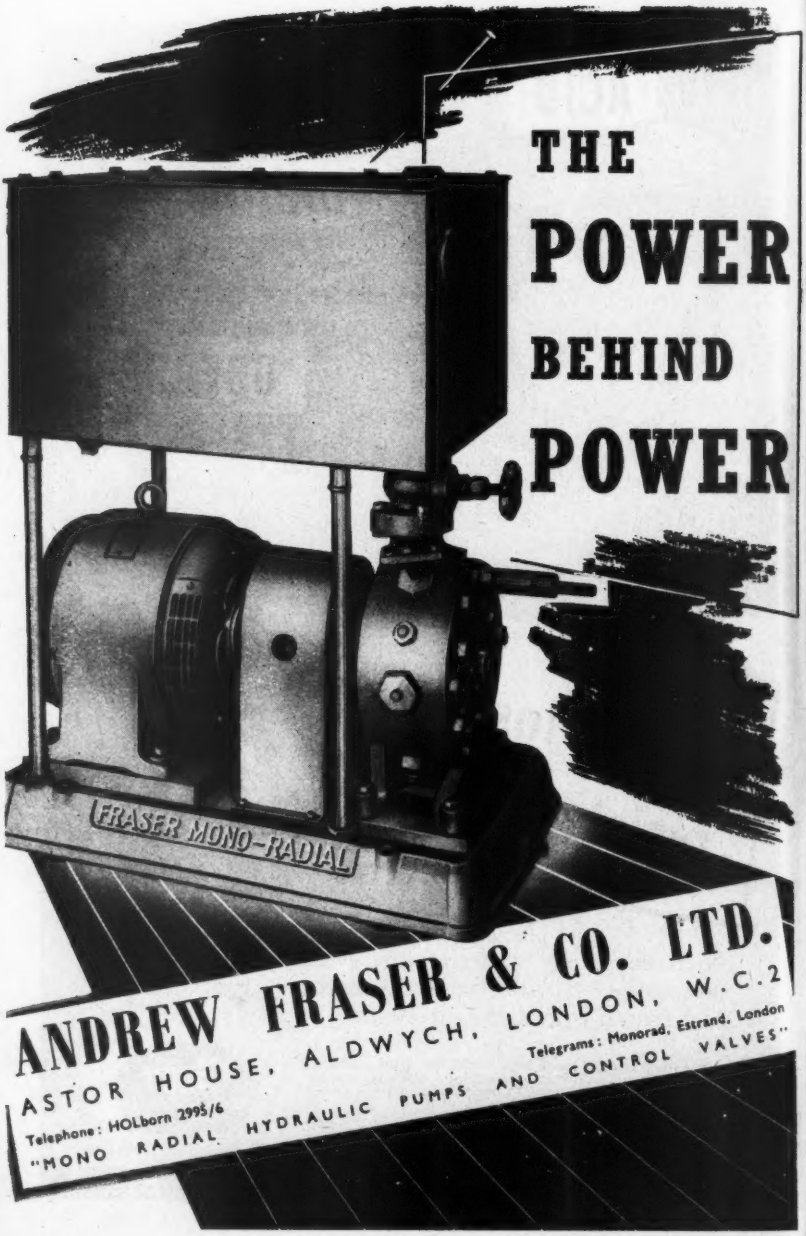
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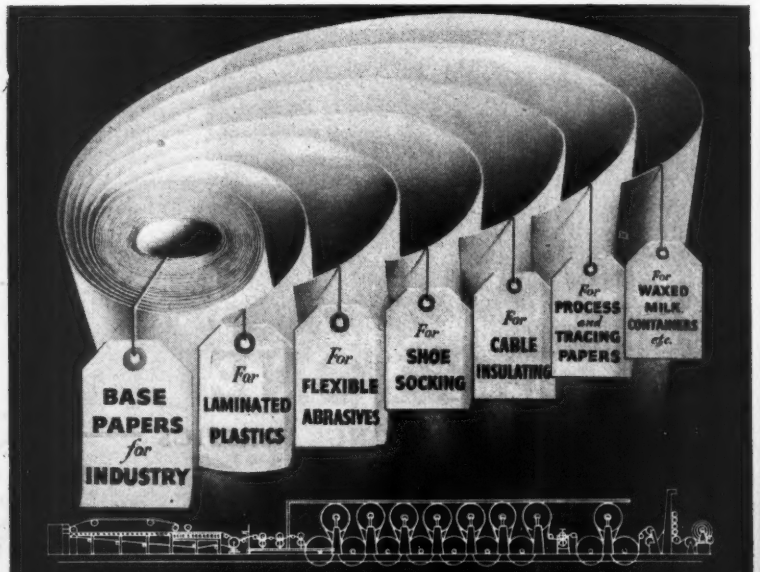

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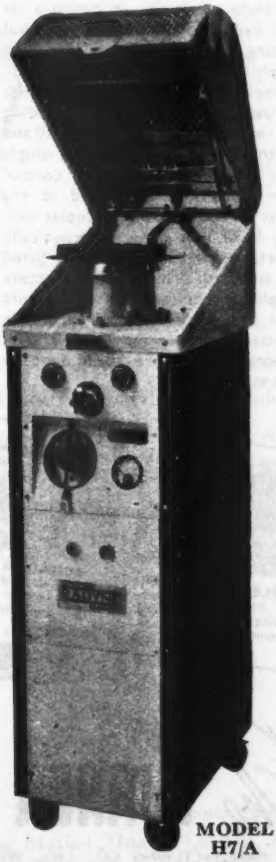

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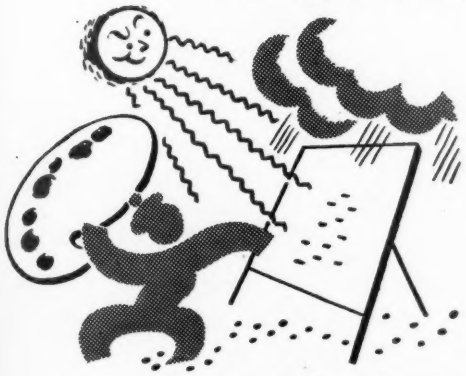

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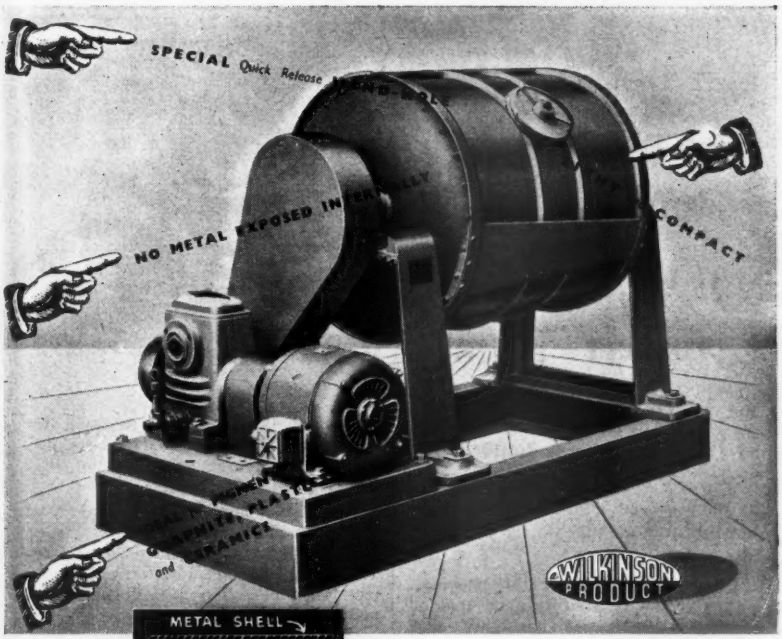

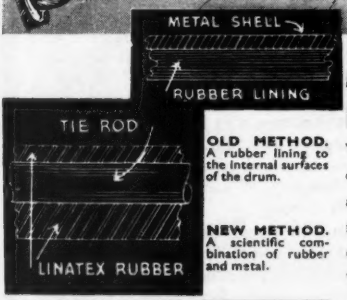

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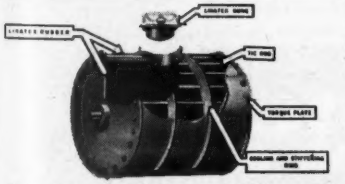

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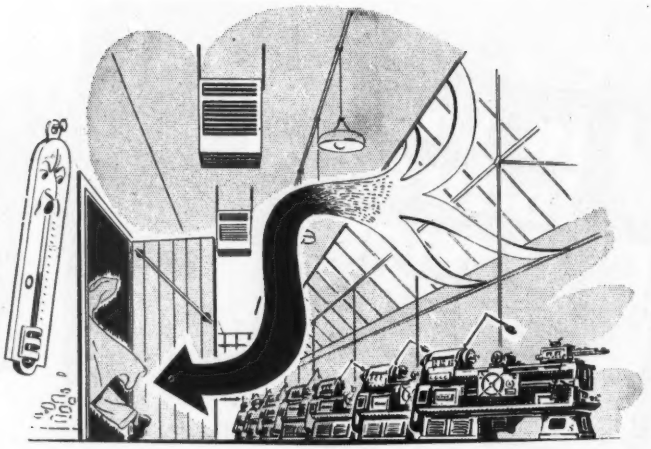

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Scene—a machine shop of a light engineering works in the Midlands. The whistle blows for dinner—down tools—up jackets—doors are flung open and the rush to the canteen is on.

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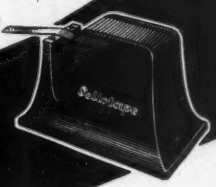

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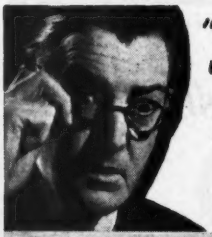

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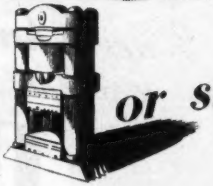

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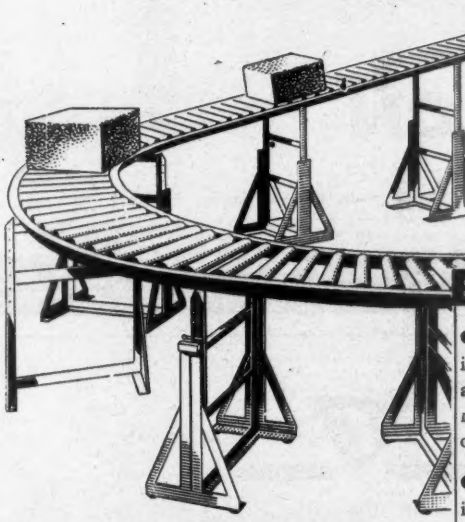

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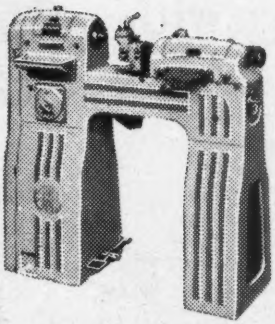

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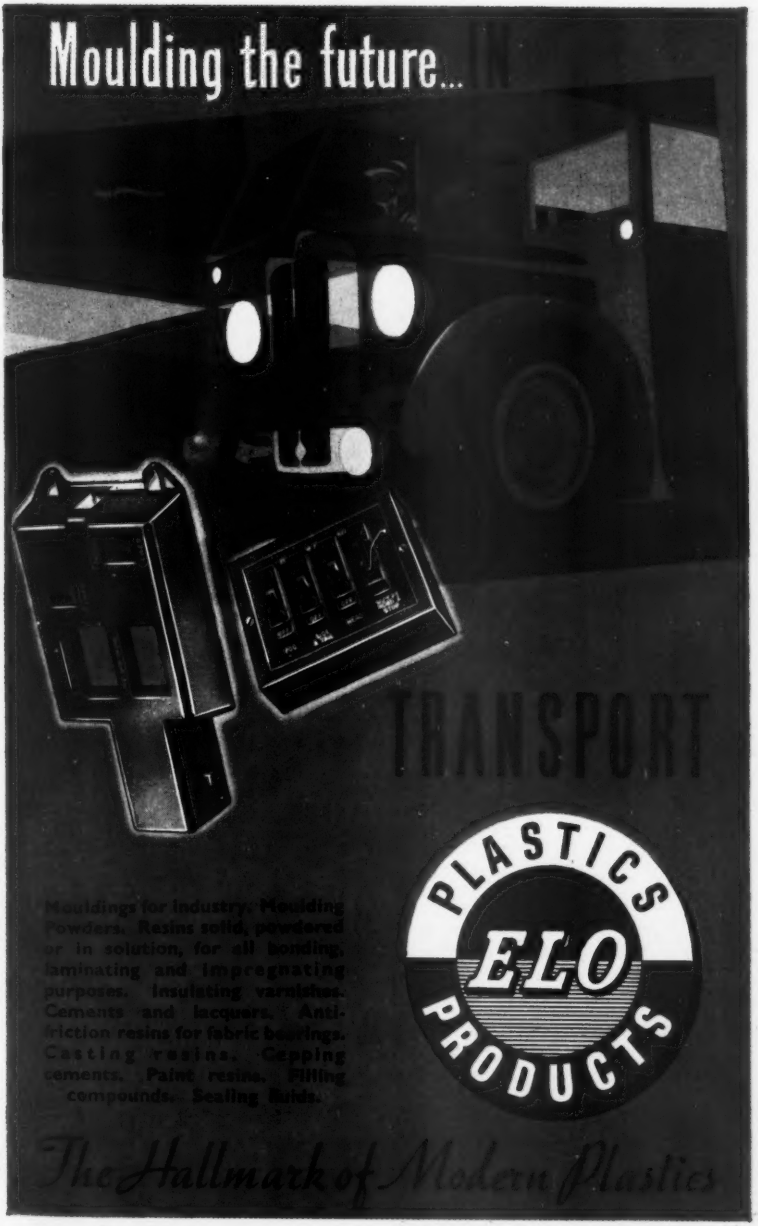
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Vol. XII. No. 129 FEBRUARY, 1948

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

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NOTICES

"PLASTICS" is published in London, England, on the second Wednesday of the month.
Annual subscription rate, 26/-. Shorter periods, pro rata.

All instructions, matter and passed proofs of all kinds of advertisements must reach the Head Office of "PLASTICS" by the 24th of preceding month to ensure insertion.

Head Offices:
Bowling Green Lane, London, E.C.1.
Inland Telegrams - - "*Pressimus, Phone, London*"
Cables - - - - "*Pressimus, London.*"
Telephone - - *Terminus* 3636 (*Private Exchange*).

Midland Offices—5, Suffolk Street, Birmingham, 1.
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EDITORIALS

Natural Raw Materials

THE recent announcement that the Government will take an active part in the development of long-neglected Colonies is indeed good news. Already we have seen concrete action in East Africa, where it is hoped great areas will be producing large quantities of groundnut oil for food purposes.

One may wonder, however, how far this action will proceed and whether or not some broad scheme will ever be available to include increased technical development of these potentially rich areas. This is not to say that nothing has already been done, nor that our ignorance of the raw materials of our colonies is profound; but the surface of such sources has scarcely been scratched.

Public knowledge of, and interest in, such far-off places, is notoriously small, but for many years past, some 20 or more within our own experience, and more before that, the Imperial Institute at South Kensington has carried out a type of research of which this country may be proud. The red Bulletins that have issued from that source in a steady stream throughout these years contain an immense amount of technical and economic knowledge. How much advantage of them has been taken we do not know, but we recommend their study to any technical or non-technical reader who is interested in industrial raw materials or in an economic knowledge of the resources of this part of the Empire. If the Government is really about to act also in the sphere of technical development, it has on its doorstep a great accumulation of valuable data.

Not that such perusal will immediately make our fortunes nor immediately make us independent of the rest of the world. But they do remind us of many possibilities which might have become probabilities. For example, about 20 years ago there was much argument in chemical circles for and against the suggestion that enormous quantities of power alcohol could be made from tropical vegetation in our colonies. Chemically, there was little doubt of producing satisfactory alcohol. Economically the problem was not quite clear. Had it been examined in greater detail, we might to-day be in a much happier situation in the light of very changed circumstances. This refers not only to fuel but to the need of our chemical and, therefore, plastic industries.

As being of more direct interest to our own industry, we should like to draw attention to one of our worst bottle-necks —the lack of phenolic compounds to make moulding powders, synthetic glues, and so on. Originally produced only by high-temperature carbonization of coal, the industry during the past few years has now accepted the phenols produced by low-temperature distillation of coal. It is also true that about 20 per cent. of our present phenol production is now made by synthetic means, a step taken by the largest producers of phenol in this country in 1939, and which has helped our situation considerably.

Even so, the phenol and other phenolic compound situation is very precarious. Exports are forbidden and the phenolic moulding powder industry has important competitive buyers in the market, not only by dyestuffs and pharmaceutical concerns, but within the plastics industry itself, for plasticizer production and so on. Perhaps most important of all is the demand for nylon. At present this is almost entirely a textile production, but since it is hoped to increase this, and since also we presume that we shall one day have nylon moulding powder, larger output of phenol must be undertaken. There is little doubt, too, that the use of phenolic resins themselves will increase.

At all events a broad outlook of the whole matter is needed and it may well

be that to offset part of the bottle-neck we should look to possible production from sources other than coal.

By a strange trick of Nature, there are plenty of phenolic compounds in the things that grow. The greatest source is wood itself and appears in the liquors resulting from paper manufacture. A good start has been made in the U.S.A. and Canada on making use of this lignin, but with the absence of mills in Great Britain, we cannot hope for such production here.

There are, however, possibilities in the importation from colonial and similar sources of oak-galls, quebracho, mimosa, which to date have been used for the production of inks and leather-tanning agents. As our readers know, some small quantities of natural phenolic compounds, especially quebracho, have been utilized to make water-purifying synthetic resins and during the war, in North Africa, moulding powders were produced from both mimosa and quebracho. Interest in these now seems to have halted.

Yet again, cashew-nut oil, which contains phenolic compounds, has also been developed and exported by other nations for resin production; on the other hand a "phenol-bearing" growth known to exist in our West Indian possessions, has to date received very little examination.

This type of research is no doubt costly and lengthy, but there is little doubt that it is worth while and would prove an asset to economic development of the Empire as a whole.

On Selling Plastics

DURING a recent broadcast a Mr. F. C. Hooper stressed the passing of the seller's market which has made the conduct of manufacture a good deal easier than it might have been. He also introduced a new slogan, "Sell or Starve," and although we believe that such "do-or-die" expressions, "Work or Want," and other alliteratives, may end up as weak in power as "wolf-wolf," there is, nevertheless, a very sound basis for all of them.

In certain industries the seller's market is still going strong, no doubt, but now that other nations are picking up (and this is a situation which this country has earnestly sought to help world recovery), there is a natural force at work insisting that we take their goods if they are to take ours. The recent announcement that we are to take about £300,000-worth of Czechoslovakia's fancy goods if we are to get other goods that we urgently need, is a case in point. Apparently, we cannot greedily eat our cake and still have it. This will not be a palatable import for those who have made quite a nice little new industry in this country of fancy goods manufacture.

There is also a distinct tendency for things to be "easing" in the plastics industry itself. While most moulders have full order books still, the rate of intake of new ones seems to have slowed down slightly. Another straw that might be showing which way the wind blows is that moulds can now be obtained well under six months from date of order, and in some instances, about three months. This may be due to increased efficiency, but on the whole we believe not.

It seems pretty certain that in the very near future we shall have to go out and get orders instead of being in the curiously "happy," but unstable and not very invigorating position of sitting at our desks and receiving them.

Is our moulding and fabricating industry ready for such an eventuality? Has it got the number of men to go in search of orders? Has it got the type of men to do such searching efficiently?

We can take it for granted that, from a sales organization point of view, the plastics industry has no strong sales force. This is not to be wondered at for, having lost it in 1939, the industry is still geared to a situation almost equivalent in character to that of the war years, namely, to a seller's market. It has not the number of men required for such an effort, nor under the present conditions of shortage of labour and direction of labour will it be able to get them easily.

What, too, of the type of men required? Obviously, the men must first be trained, for without a sound knowledge of the industry they would not be worth their salt. We do not mean that by merely looking at a proposed job they should be able to give all the answers. That must be left to the costing and other departments. But they must be able to tell whether or not a job is possible at all, to discuss intelligently the probable process to be adopted and the most suitable plastics to be employed. They must not only get new orders but must also act as a preliminary sieve to separate the wheat from the chaff and thus to save much unnecessary work on the part of the managerial side.

This knowledge is gained only by a thorough acquaintance with the industry and, more particularly, with the moulding shops; there is no better training for such men than practical work within them and if we place the necessary period of such work at six months, it is far from being too long. Directors should have this six months in mind when considering the time available for putting such a force out.

Transport of Flowers

A SHORT time ago the British Flower Growers' Association held a meeting to discuss the appalling situation so far as the wooden containers used for dispatching flowers by rail were concerned; there is so little wood available for their making, and the returnable container idea completely breaks down because they are stolen, broken up for firewood in these days of fuel shortage, or otherwise lost.

We were asked on this occasion to give our views on the possibility of utilizing plastics for the purpose, but could give no real hope. The main snags are, the size of the box, which can be very large indeed (often about 2 to 3 ft. long by 1 ft. wide), and the bashing about that such boxes receive in transport. Thus the only possibility is some form of laminated box which would probably be high in price and might not stand up to transport so long as the thick wooden ones, unless they were of resin-impregnated wooden veneers. Quite apart from price, however, the shortage of wooden veneers, and, indeed, of paper fabric, reduces the value of such an idea to zero. The possibility of using board such as is now being made in this country by bonding wood-waste with urea resins would probably be applicable only to single-journey boxes, unless some system of greater care in stacking and transport were introduced. This material could, however, be employed in an exactly similar manner to box making from wooden slats by nailing.

We made a final suggestion of the production of entirely novel methods of flower packing, by the use of the light honeycomb structure as typified by Dufaylite produced by Dufay-Chromex, Ltd., which we described in our July, 1947, issue. Each honeycomb cell would be the recipient of, say, half a dozen flower stems, each half-dozen being amply protected from the contents of the next cell by the resin-impregnated cell wall. The structure would be quite strong in itself, especially if further reinforced by a simple wire construction. Here, again, the paper situation is a great deterrent, for there must be tens of thousands of such boxes required. But at least we can say there would be no incentive to steal them, for they would not relieve the fuel situation!

BRUSSELS PLASTICS FAIR

The Belgian Plastics Office is organizing a Commercial and Industrial Plastics Fair to be held from May 29 to June 13 in one of the great halls of the Centenaire under the name of 1st Internation Plastics Fair. It will be held at the same time as the Housing and Decorative Arts Exhibition.

Foreign participation will be welcomed and inquiries should be sent to:—

Mr. Servranckx,
Office Belge des Matières Plastiques,
153 Chaussée de Bruxelles,
Bruxelles-Forest.

Protection for Polished Metal Sheets

DURING the recent war, when tropical proofing became of such vital importance, the protection of metals against corrosion was carried out in a variety of forms—coating with grease, such as lanoline, and later, lanoline and resin mixtures, followed by wrapping in greaseproof paper, paper treated with paraffin wax and copper naphthenate, and so on. Synthetic waxes, waxes modified with plastics to toughen the finished coating, were also introduced with and without solvents.

A more recent development, known as "Birlon," is a plastic coating developed jointly by Cellon, Ltd., of Kingston-on-Thames, Surrey, and Birmetals, Ltd., of Quinton, Birmingham. The film can be sprayed on the metal to be protected, or can be formed by the simple process of dipping.

"Birlon" has been prepared primarily for the temporary protection of the polished surface of light metal alloy sheets. It takes the form of a transparent flexible film, which adheres to the surface of the metal, and not only protects it indefinitely from tarnish and scratching, but is also tough and elastic. The specially prepared plastic is applied by spray or roller—preferably the latter—under controlled conditions of heat and humidity. A film of 0.001 to 0.002 in. is recommended, according to the purpose for which it is intended. Such a film is highly resistant to penetration of moisture.

The film air-dries in 20 to 30 mins., and has an extremely high tensile strength, coupled with great elasticity. It adheres tightly to the surface of the metal like a thin skin, but when its purpose has been served it can be removed very easily, without the use of solvents, by merely lifting a corner and pulling it off.

The most valuable application of this "Birlon" coating is in protecting bright metals from the rolling mills through the stages of handling, pressing and storage. The film is sufficiently tough to permit of sheet metal being pressed before it is removed. It forms a cushion between the metal and the dies, thus considerably prolonging the life of press tools.

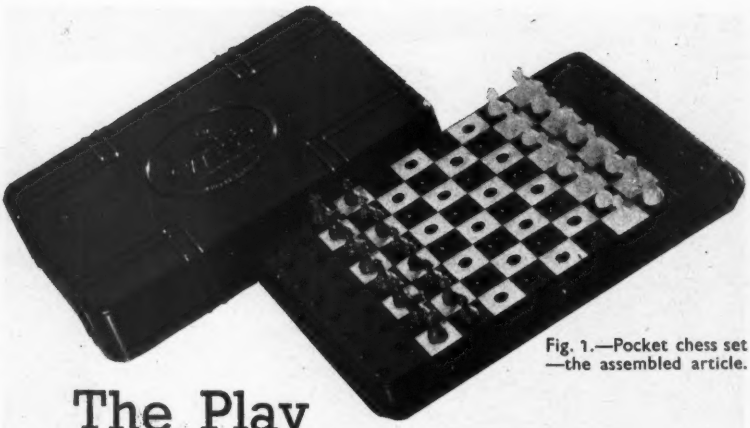


Fig. 1.—Pocket chess set —the assembled article.

The Play of the King

200 B.C. Carved Jade and Ivory
A.D. 1948 Injection-moulded Cellulose Acetate

MOULDERS and fabricators from plastics may or may not be interested in chess as a game to play in their lunch and other leisure hours. We are quite certain, however, that many regard it, quite rightly in our opinion, as a legitimate outlet for their raw materials and their ingenuity. The intangible beauty of the set, the very number of "men" in each one and the widespread popularity of the game obviously warrants such expression.

Plastic sets, or rather, chessmen of the standard large size, are by no means new, sometimes—although rarely—pressure moulded, more often turned from casein, phenolic castings or methyl methacrylate resin, as we have recently seen in these pages.

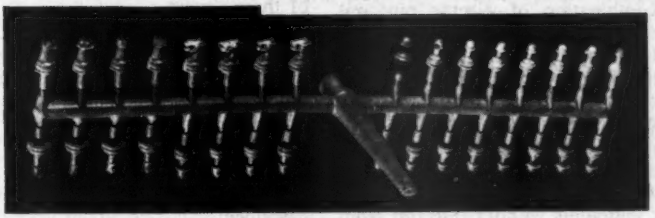
The pocket plastics chess set is much more of a novelty, and here it would seem that, because of the small size, fabrication by turning and otherwise machining would not only be difficult, but almost certainly uneconomic. On the other hand, the injection moulding of the set becomes a fact, not merely for the moulding of the men, but also of the complete set, playing board and case.

It is, therefore, with special interest that we have examined a new production by Nicholas, Ltd., of 1, Bradley Road, Wood Green, London, N.22. It has been completely moulded at these works in cellulose acetate on E.M.B. No. 9 machines.

The overall dimensions of the lid and base are 6 ins. by 4⅜ ins. by 1¼ ins., the moulding consisting of lid and base in red, playing board in black, but with sprayed alternate white squares and 32 red and white chessmen. The size of the chessmen varies from ⅜-in. pawns to 15-32-in. kings. All the pieces have 9-32-in. shanks, so that the "men" are quite stable and cannot fall out of the holes in the board when the lid is closed.

The appearance of the set is excellent, the chessmen are clean-cut and beautifully moulded, so that great credit is due not only to Nicholas, Ltd., the moulders, but also to Fox and Offord, Ltd., Alma Street, Aston, Birmingham, 6, who made the injection moulds.

Fig. 2.—Lid, playing board and chessmen, as moulded, showing sprues and paper knives.



Since this is the first injection moulded chess set we have seen on the market, it may be worth while including the following details of the component and tool design.

The assembled article was designed with a view to sales appeal, and especially with regard to overcoming toolmaking and moulding difficulties. Assembly of the components is a very simple operation and is effected by four self-tapping screws, which hold the base and playing board together permanently. Spring-loaded plungers housed between these parts fit in moulded recesses in the lid, positively holding it in position until it is to be removed, when it can be retained on the underside of the base on a register specially provided for this purpose. There are shanks on the chessmen which fit in holes in the playing board, and the overall height of each man is such that it cannot fall out of its position when the lid is closed.

The moulds were made for use on an E.M.B. No. 9 injection machine, and as this is designed for a central sprue, the impression form in the lid, playing board and base moulds on one side of the sprue would have given an out-of-balance

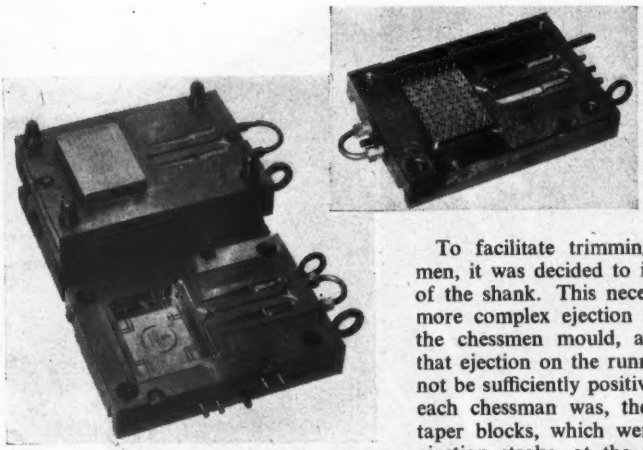


Fig. 3. — The moulds for the lid and the playing board.

loading on the machine platen. To counteract this, paper-knife impressions with the maximum permissible projected areas and yet coming within the shot capacity of the machine, were cut on the opposite side of the sprue. Ejection of the mouldings on these three moulds is by a combination of ejector pin and stripper plate design. By an automatically delayed action, the ejector pins push out the paper knives first, and then the stripper plate removes the chess box mouldings from the cores. In the case of the lid mould, the gate entries were made so that the moulding could spring over the projecting pieces forming the plunger undercuts without restraint from the runners, and also to give the best material flow, thus avoiding possible moulding distortion.

To facilitate trimming of the chessmen, it was decided to inject at the end of the shank. This necessitated a rather more complex ejection arrangement for the chessmen mould, as it was feared that ejection on the runners alone would not be sufficiently positive. The head of each chessman was, therefore, cut into taper blocks, which were raised on the ejection stroke, at the same time automatically retracting from the mouldings so that the whole moulded spray could readily fall clear of the open mould. These taper blocks were prevented from dropping out, but could be extracted for cleaning or other purposes without taking the mould from the press by the removal of three screws.

The sprues and die blocks of all the moulds were water cooled to give a fast moulding cycle, and the die faces were relieved to give maximum air venting to the mould impression forms.

We are indebted to Fox and Offord, Ltd., for information on the various details of the moulds, as here described.

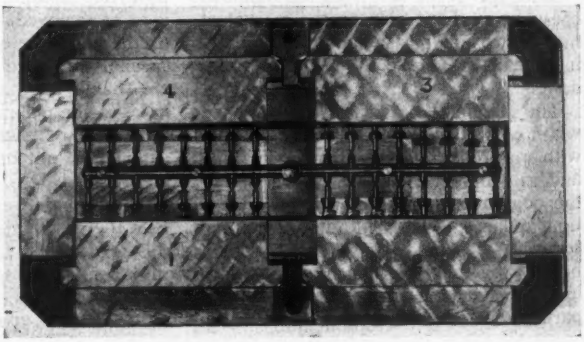


Fig. 4.—One half of the mould for the chessmen.

Book Reviews

"Practical Emulsions." By H. Bennett. Pp. xiii + 568. Chemical Publishing Co., Brooklyn, New York, and Chapman and Hall, Ltd., London. 48s. net.

Mr. Bennett is very well known in the chemical industry, having written an excellent chemical and technical dictionary, and the present book, which is now in its second edition and in its field no less excellent.

The production and occurrence of emulsions are fantastically wide. The difficulties of making them efficiently—that is, stable—or, alternatively, of breaking them down, as is so often necessary in certain industries, are a measure of the limits of our knowledge of surface reactions. So much is this true that it can be said many of the technical emulsions on the market have probably been constructed on a hit-or-miss method, followed by very careful repetition under exactly controlled conditions. On the other hand, the general scientific principles are well known and, with such a book as this, most workers can be sure of some success in most fields of emulsion production.

Opening, in Part I, with a chapter on types of emulsions, the author gives a very full account of the large number of emulsifying agents that are available, and follows with chapters on foams, methods, formulation, and the equipment necessary to produce emulsions. There is also a general chapter on stability, from a physico-chemical point of view.

Part II is an interesting and valuable inclusion, for it comprises a number of scientific papers on emulsifying agents and emulsions.

Part III is by far the larger portion of the book; it is a compilation of a vast number of formulæ for producing almost any type of known emulsion, ranging from agricultural sprays to cosmetics, and from lubricants to textile emulsions.

The Technology of Adhesives. By John Dalmonte. Pp. viii + 516. Reinhold Publishing Corporation, New York, and Chapman and Hall, Ltd., London. 48s. net.

There have rarely, in the past, been good books on the subject of adhesives. This condition has resulted mainly because so little has been known about the physical, chemical and mechanical actions that take place when sticking two things together. While we are far from knowing all about adhesion, we now know more than we did 10 or 20 years ago. The matter is, moreover, much more complicated by the great increase in types that have been successfully adopted.

Mr. Delmonte's experience of the subject, more especially in the realm of synthetic adhesives, is obviously deep and wide—our readers perhaps know that he is technical director of the well-known Plastics Technical Institute of Los Angeles, California, and he has written a book much in advance in composition and extent of any we have yet seen. The present work is especially sound because he does not restrict himself to the newer synthetic varieties, but maintains a scientific balance between all types, synthetic resins of both thermosetting and thermoplastic types, cellulosic and starch derivatives, natural resins, gums, protein types, animal glues, rubber and, finally, inorganic adhesives and cements. There are 20 chapters in all, and after a historical introduction with a chemical classification of all types, each general type is dealt with in separate chapters. An excellent description of the theories of adhesive action is included.

The remaining chapters deal with practical and specific applications, such as "Adhesives for Wood," "Cementing of Organic Plastics," "Adhesives for Metal and Rubber," "Adhesives for Tapes, Paper Cloths and Foils" and "Adhesives for Inorganic Materials." We note with interest the inclusion in "Cementing of Organic Plastics" some notes on heat welding, high-frequency welding and friction welding. While this type of jointing may not be considered as examples of adhesion in the commonly accepted sense, its inclusion is very valuable to the technician. Finally, Mr. Delmonte includes a chapter on "Tests and Specifications for Adhesives."

"Handicraft in Plastics." By Benjamin T. Richards. Pp. 92. G. Bell and Sons, Ltd., 3s. 6d. net.

This is a useful little book for those who wish to carry out handicraft in schools and clubs, with simple, but clear descriptions of the methods of shaping, cutting, forming, cementing, etc., and of the tools required. The author deals only with Perspex, Catalin, Lactoid, and Ermoid, which latter two plastics he appears to consider as of different origin. For some unknown reason he has not included cellulose acetate sheet as worthy of consideration. In spite of these limitations, the book is quite acceptable, especially since he does indicate where the raw material can be obtained.

J

Cellulose Acetate Plastics

IX.—Manufacture of Sheeting: (a) Block Process

By
Vivian Stannett

THIN cellulose acetate sheeting is mainly manufactured by the solvent casting method, already described. As this method is not economical for thicknesses greater than about 10/1,000 in., other methods are used for the production of thicker sheeting. The bulk of the heavier gauge material is manufactured by the block method, although extrusion methods have also been successfully developed especially for sheeting within the 20/1,000 to 40/1,000-in. thickness range.

The block process of sheeting manufacture was originally developed for the production of celluloid sheet and is still used for this purpose. With the development of cellulose acetate, however, it was natural to extend its use to the production of this type of sheeting. The process appears cumbersome and old fashioned to the observer, as indeed it is, but so far no other method has been found to replace it, especially for thicknesses above 40/1,000 in. and it is still the standard method employed all over the world for the manufacture of thick celluloid and cellulose acetate sheeting. The essential stages in the method are summarized in Fig. 1.

Mixing

The cellulose acetate, plasticizers, solvents and other ingredients are compounded in the form of a heavy dough, containing about 30 per cent. of volatile solvents. Two typical mix formulæ are given in Table I. Acetone is not usually employed as the only solvent owing to its high volatility; it is often mixed with substantial quantities of diluent such as alcohols and benzene. A small proportion of water is sometimes added, both to reduce the solvent cost and to decrease the drying rate a little. Heavy brass Werner-Pfleiderer mixers are used, of the type illustrated in Fig. 2. They are jacketed for cooling purposes and fitted with close-fitting lids which are sometimes attached to a solvent recovery system.

Mixing is carried out until a completely homogeneous mass is obtained, this normally taking from 4 to 8 hours. Pigments are added in the form of a slurry with solvent, or rolled into stock to give even distribution. Pigments are often ground under solvent or plasticizer in a ball mill or triple roller mill before adding, in order to ensure even wetting and subdivision. This is necessary for the production of a smooth colour, free from speckles and grit. Dyes are usually added in the form of solution, preferably filtered before addition, methanol being a particularly useful solvent for this purpose.

When the mixing is judged to be complete, a sample of the plastic dough is withdrawn, rolled into a sheet of the correct thickness and polished by hot-pressing between polished metal plates. The colour of this sample is then checked against the standard, and if incorrect it is adjusted by the addition of further quantities of pigment, etc., followed by remixing and retesting. When the colour is approved, the mass is ejected from the mixer by tilting and reversing the stirring. At this stage, the mix still resembles a heavy dough in consistency.

Table 1.

Typical Mix Formulæ.

	Clear Transparent	White Opaque
Cellulose acetate ..	200 lb.	200 lb.
Dimethyl phthalate	46 lb.	54 lb.
Triphenyl phosphate	14 lb.	16 lb.
Acetone	100 lb.	100 lb.
Methylated spirit ..	20 lb.	20 lb.
Benzene	20 lb.	25 lb.
Zinc oxide	—	18 lb.

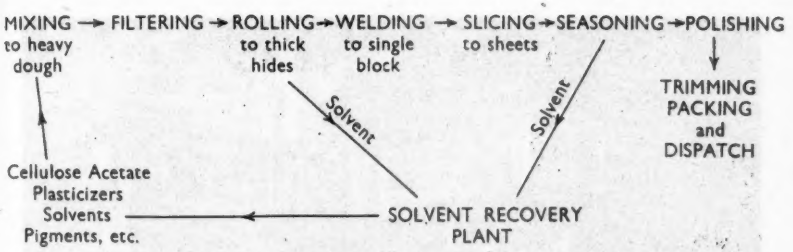


Fig. 1.—Flow sheet for production of cellulose acetate sheet.

Filtration

The filtration of such a highly viscous material cannot be carried out by normal methods and it has to be done discontinuously by cutting smaller portions from the batch and forcing them through a filter plate, covered with a system of metal gauzes and filter cloths. The plant consists usually of a simple vertical ram and cylinder device, the dough being placed in the cylinder and the ram exerting a pressure of 1 to 3 tons per sq. in. The type of machine used for cordite production is suitable for this work. As the dough emerges from the filter press, it resembles macaroni or thick sausage-like rods, according to the type of plate used.

Rolling

The filtered dough or stock at this stage of the process still contains about 30 per cent. of volatile solvents. It is now worked on warm rolls until the solvent content drops to the order of 10 to 12 per cent. The rolling machine consists of a pair of massive plated rolls arranged horizontally, fitted with steam heating and water cooling. The size of the rolls varies from factory to factory, but a popular size is about 18-in. diameter and 40 in. in length. They are enclosed on three sides and fitted with solvent recovery suction. The front is arranged to give maximum efficiency with respect to solvent recovery and to keep the workers away from fumes.

About 100 lb. of filtered stock is cut out and dropped on to the rolls where it forms a blanket around the front roll. The heat of the rolls is so adjusted that

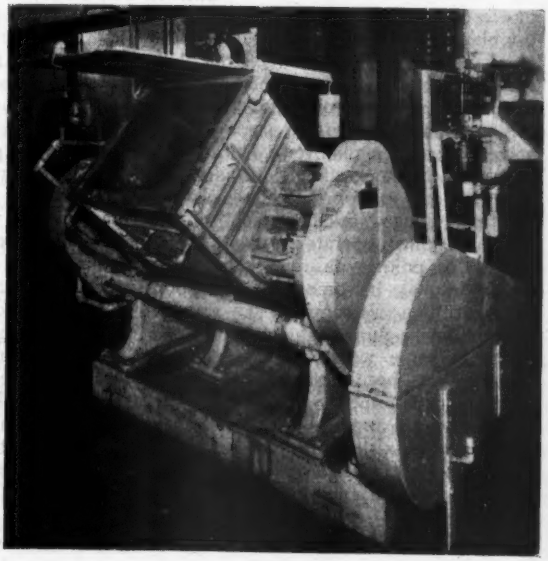


Fig. 2.—Mixer for cellulose acetate or cellulose nitrate. (Courtesy, Monsanto Chemical Co., U.S.A.)

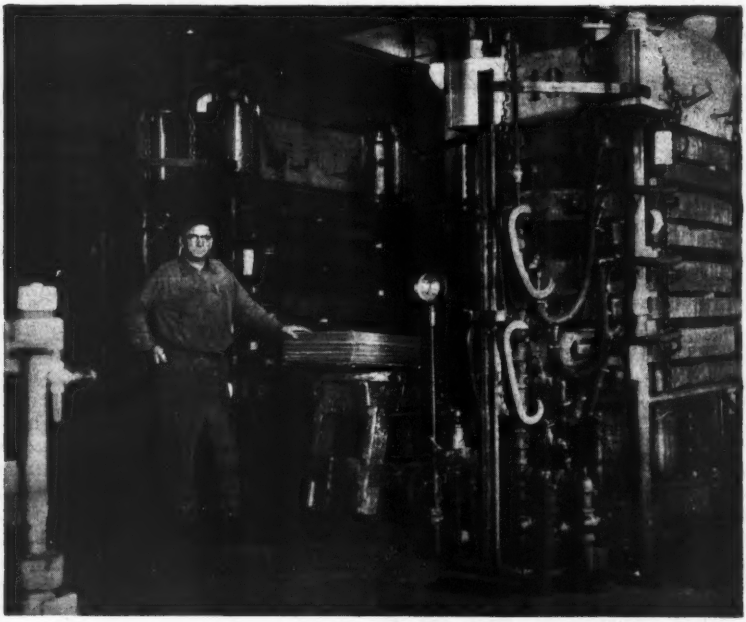


Fig. 3.—Loading the welding press (multi-block type). (Courtesy, Monsanto Chemical Co., U.S.A.)

the blanket, which always adheres to the hottest roller, forms on the front roll. Here it is continually cut and put back into the nip of the rolls and worked in this way until the correct proportion of solvents has been removed. During this operation the stock stiffens considerably, and the point to stop the rolling process is usually judged by the "feel" of the stock, a skilled operator being able to judge this point with remarkably consistent results. In some cases, the point where rolling is complete is roughly checked by weighing the stock before and after; in some works, elaborate paper records have been designed, which are kept by the operators in order to standardize the process. Success of the job depends on the skill and experience of the operator. It is usual for two men to work on one rolling machine, each looking after the cutting and working of half the length of the blanket.

When the rolling is complete, the stock is removed; the nip of the rolls is then set with a gap of about 1 in., the stock is thrown back on to the rolls and run off into sheet an inch thick. Some factories keep a special set of sheeting rollers to carry out this latter operation in order to avoid stopping the rolling machine and so causing some loss of production. The inch-thick hide is then cut by means of a template and the trimmed sheet laid on the grooved metal base-plate ready for pressing.

The rolling process is repeated with fresh stock until about six trimmed sheets are assembled on the base-plate. The ends from the trimming operation can be reworked to give a thinner sheet, which can then form the base of the stack of hides or can be thinned out for remixing with further batches. The base-plate itself is made of steel, is about 1½ in. thick and grooved to give a firm

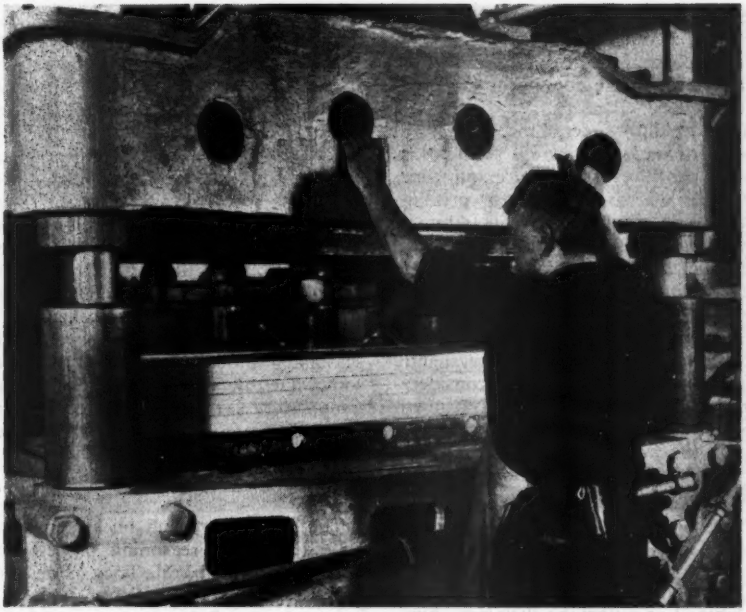


Fig. 4.—Closing the welding press. (Courtesy, Monsanto Chemical Co., U.S.A.)

weld unto the plastic block during pressing.

Normally, the base plate is already covered with acetate remaining from a previous welding operation, although after several pressings this material is cleaned off and a fresh "base" welded on. The size of the base-plate used depends on the welding press, a common size being 54 ins. long by 25 ins. wide. The total depth of the block, including the base-plate, is normally about 8 ins., although some manufacturers tend to work with a shorter load. This gives consistently better block, but leads to a higher proportion of trimming waste and, of course, smaller production for the same time cycle during welding.

Pressing

The base-plate, complete with the stacked hides, is then lowered into the blocking press, the top slab being first covered with a thin steel plate. The presses are heavy well or box types, and pressure is applied by both top and bottom rams. A further type of press, sometimes used, is a fixed-head daylight press, with special fittings, which can be arranged to completely enclose the block while pressure is being applied. Presses of both types are available which are capable of welding three blocks at one time, the blocks being separated by heating or cooling platens. In the case of the well presses, the walls of the "box" are also sometimes drilled for heating and cooling purposes.

The block is first subjected to several hours heating at about 95 degrees C. at one ton per sq. in. pressure. The heat is then turned off and the water cooling turned on; during cooling it is usual to increase the pressure somewhat. Several hours are required to cool the blocks sufficiently for removal from the press without damage, the total time cycle being of the order of 12 hours. The

pressure is then released, and the blocks are ejected and put on one side for as long as possible before cutting, in order to enable complete cooling of the block to take place.

The welding operation is not as straightforward as it would seem to be. Large quantities of scrap are sometimes produced, due to unsuccessful pressing. One of the chief sources of failure is fluctuating pressure during welding; hydraulic equipment of especially high quality, with high capacity accumulators, is essential. Also, variations in the composition of the mix and in the rolling operation lead to the necessity for slightly different welding times. These considerations are more important than they might appear, as in order to give maximum production the welding time cycle is usually cut to a minimum. The weight of plastic welded into a single block is usually 400 to 500 lb.

Slicing and Seasoning

The cold block is now hoisted on to the table of an automatic slicing machine, which is provided with a fixed knife, the height of which is adjustable. The block is bolted to the table, which moves backward and forward under the knife. When a sheet has been cut, the block runs back to the starting position under the knife, which drops automatically the same distance, as before, and cuts a further sheet of exactly the same thickness. In this way the block is completely sliced to a pile of sheets of remarkably even thickness.

The slicing process is well illustrated by Fig. 5. Thicknesses from about 5/1,000 in. up to about 8 mm. can be comfortably cut on this type of machine. Not all the sheets, of course, are free from faults, and considerable losses are sometimes encountered due to bubbles and blisters formed during the welding operation. Scrap is produced from the top cuts and also near the base. A yield of more than 90 per cent., however, is frequently obtained from a satisfactorily welded block.

The sheets at this stage still contain about 10 per cent. of volatile solvents and show marked striations from the knife cut; the thickness has to be adjusted to allow for the shrinkage which occurs when this solvent is removed. Solvent removal is carried out by hanging the sheets on racks in warm seasoning rooms, fitted with suction pipes linked to the solvent recovery system. Temperatures of the seasoning rooms are kept in the neighbourhood of 40 degrees C. The length of time taken for virtually complete removal of the solvent varies from a few days to several weeks, according to the thickness of the sheets. The seasoning process can be accelerated somewhat by using a secondary high temperature seasoning room, kept at 60 to 65 degrees C., or by use of vacuum seasoning ovens.

Polishing

The sheets warp and buckle considerably during the seasoning process and also show distinct knife lines. For some purposes, however, the poor surface is unimportant and the sheets are ready for use after flattening. This latter operation is carried out by hot pressing between steel plates in a platen press, cooling, and then removing. The flattened sheets are trimmed to size, and are then ready for packing and dispatch. For most purposes, however, a highly polished surface is required, particularly in the transparent grades, in order to give perfect transparency and a crystal-clear finish.

Polishing is carried out by pressing the plastic sheet between two highly polished metal plates under heat. The polishing plates are usually made of nickel or nickel-plated brass, and are polished to a very high and even lustre. Such plates have to be frequently renewed and rebuffed. Owing to their susceptibility to scratching they have to be handled with great care, and usually at least two men are employed on each press. A multi-platen daylight press is used, and a great many sheets are assembled together between each set of platens. In order to take up any unevenness in pressure, the stacks are usually arranged with paper

Fig. 5.—Slicing a block of decorative acetate sheeting. (Courtesy, Monsanto Chemical Co., U.S.A.)

packing between each set of polishing plates. Steam is passed through the platens, and the plastic sheets are treated at about 95 degrees C. and a pressure of one ton for several minutes. When the steam is turned off, water cooling is applied until the sheets are thoroughly cooled; the pressure is then released, and the assemblies are removed and separated. The polished sheets are trimmed to size by guillotine if thin, or by band saw if thick.

Thicker-gauge sheeting is usually buffed after trimming to remove any slight scratches reproduced from the polishing plate or during handling. The sheets are then ready for packing and dispatch. For some purposes, however, a matted or embossed finish may be required, or perhaps one side of the sheet polished and one side matt. These variations can be carried out by substituting a matted or embossed metal plate for one or both of the polishing plates.

Cylindrical Blocks

In addition to the normal rectangular blocks, presses are available for making cylindrical blocks. Here the plastic dough is rolled to the correct solvent content, and the stock is then calendered into a long, continuous sheet, which is wound round a central metal core attached to a circular baseplate. This assembly is then lowered into a cylindrical block press and welded under heat and pressure as before. The presses are arranged so that the central core of the cylinder fits into a hole drilled in the ram. In this way the height of the block can also be adjusted to any desired amount. Cylindrical blocks are sliced on special-type machines on which the block rotates.

Special Effects

The block method of sheet manufacture lends itself particularly well to the production of many special types of decorative sheeting, including mottles and imitation tortoise-shell, ivory, mother-of-pearl and horn effects. The manufacture of these types of sheeting, however, is a specialized and elaborate process, requiring great experience if a really accurate imitation is desired.

(*Continued on page* 84)

World's Industry Employs Plastics

GENERAL ENGINEERING

Vibration damper of the viscous torsional type using a small volume of high viscosity silicone fluid has been introduced by Houdaille-Hershey Corporation. Originally used for large Diesel engines, it is now mass produced on a welded design for popular makes of private car engines. ("Autom. Industries," 1947/Dec. 1/24.)

Vulcanized fibre has been successfully employed for machine parts ever since it was first commercially made in the early 1900s. Selected applications, such as gears, self-locking nuts, gaskets, insulation, abrasive discs, link-belts, shuttles, etc., are described in "Machine Design," 1947/Nov./109.

Engine Mounting.—Conical steel spring and rubber mounting for engines and motors is said to give greater horizontal stability during starting; units from 25 to 125 lb. load capacity are produced by The Korfund Co., Inc., 48-12 32nd Place, Long Island City 1, N.Y. ("Product Engineering," 1947/Dec./196.)

Bonded rod of a tough pliable plastic can be wound on reels and used in the same way as metal wires. The rod is made of powdered "Colmonoy No. 6." (Wall Colmonoy Corporation, Detroit, Mich.) combined with a plastic binder and extruded to size. ("Product Engineering," 1947/Dec./200.)

Contoured Plastic Shapes.—Th. A. Dickinson refers to the application of vacuum technique for forming contoured shapes in thermoplastics. Concave or convex moulds can be used; the technique is applicable to the manufacture of optical lenses. ("Tool Engineer," 1947/Dec./41.)

Foundry Patterns.—Match-plates, cope and drag equipment, and master pattern duplicates made from cast plastics are giving good results at many foundries. A new phenolic resin patching material, "Resi-Plast," can be handled like clay and is used to repair broken plastic patterns. An excellent bond is formed after air drying for 24 hrs. at room temperature. ("Production Engineering and Management," 1947/Nov./80.)

Impact Loading.—Investigations on the resistance of plastics to impact loading have been carried out by H. Liander, C. Schaub and A. Asplund. Notice is taken of the kinetic energy of the fractured piece and of other losses. By use of increasing-blow method with a falling-weight machine or a pendulum, and by referring to the total loaded volume of the test specimens, the impact resistance value thus obtained is said to give a better measure of the qualities of the material concerned. The data obtained appear to be independent of the dimensions of the test specimen. ("A.S.T.M. Bulletin," 1947/Oct./88.)

Flexure testing apparatus examines plastic specimen as a single beam loaded at the centre. The span can be quickly adjusted to the desired value with a calibrated screw, to facilitate the testing of specimens of different thickness at the same span-depth ratio. ("A.S.T.M. Bulletin," 1947/Oct./96.)

Flame-spraying of plastics is a recent development in the protection of such materials as earthenware, wood and metal. The plastic is passed through an oxy-acetylene or oxy-propane flame, to be softened and melted and so deposited in a fused and homogeneous layer on any suitable surface. ("Chemical Age," 1947/Dec. 6/722.)

MISCELLANEOUS

Laminated floor tile, "Plastile," produced by United States Stoneware Co., Akron, Ohio, is recommended for laboratories, chemical works and similar situations. It has a non-slip and resilient top surface of 3-32 in. "Tygon," combined with a 3-32 in. bottom layer of synthetic resin-impregnated cork. ("Products Finishing," 1947/12/118.)

Adhesion of Coatings.—Information on strength of organic coatings and their relative degree of attachment to the base metal has been obtained by an abrasive blasting method developed by K. G. Compton, of Bell Telephone Laboratories Inc. ("Products Finishing," 1947/Dec./68.)

Wear testing of plastics can be done on a new machine designed by N. N. Sawin. ("Tool Engineer," 1947/Dec./17.) The powdered particles of the sample act as the principal factor in forming the impressions.

Motor control switches, redesigned in phenolic plastics by Furnas Electric Co., Batavia, Ill., demonstrate the saving to be made with moulded products. ("Product Engineering," 1947/Dec./98.)

General techniques of moulding and finishing low pressure products were discussed by A. E. Wiles before the Society of the Plastics Industry, Chicago. ("Product Engineering," 1947/Dec./126.)

Thermosetting resin cements are described by N. J. De Lollies in an illustrated article covering applications in wood, metal-to-wood, metal-to-metal, metal-to-glass and plastic and rubber bonding. ("Product Engineering," 1947/Dec./137).

Faucet washers of injection moulded nylon seem to present a number of advantages over traditional washers of natural and synthetic rubber or fibre. Nylon can withstand intermittent service in hot and cold water, as it is little influenced under thermal changes. Foreign particles embed themselves in the washer rather than hold open the valve. The toughness of the material resists the cutting and wear to which washer material is subjected. Such washers are produced in eight diameters by Atlantic Plastics Inc. ("Scientific American," 1947/Dec./267.

Motorcar Windows.—Necessity for proper choice and control of light transmission characteristics of acrylic plastics in large area glazing for motorcar bodies is stressed by W. F. Bartoc. Ultraviolet absorbing "Plexiglas" has been developed to eliminate the "sunburn" wavelengths without changing the visible appearance of the base material, i.e., without introducing any colour. ("Autom. Industries," 1947/Dec. 1/39.)

Power Transmission Belts.—United States Rubber Co. (L. H. Gilmar Division) have developed a strong, highly flexible and noiseless belt with rubber teeth on the inner face, for use with specially grooved pulleys. Positive engagement similar to tooth or roller chains is thereby obtained. ("Autom. Industries," 1947/Dec. 1/56.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

Ingenuity in New Australian Plastic Products

by Charles Lynch

NEW designs in domestic appliances, in sporting requisites and products for personal use are among the latest developments in the expanding industries associated with plastics in Australia.

Refrigerators

The first all-plastic refrigerator made in Australia recently appeared on the market. It is made of paper base laminate, thus eliminating the need for forming dies and for the press equipment usually required for the pressed metal type of cabinet. The unit has a capacity of 7 cubic feet, and takes up less floor space than similar all-metal types. (An illustration of this refrigerator was published in "Plastics," August 1947, p. 399.)

Contact Lenses

Plastic contact lenses are now being made locally. These oval-shaped lenses are worn under the eyelids by people, who for various reasons cannot or do not wish to wear spectacles. Swimmers, actors, and football, cricket and tennis players, sometimes use them; soldiers and airmen find them preferable to spectacles. They are of polymethyl methacrylate and consist of two parts, the soleral portion which rests on the whites of the eye, and the corneal portion, a ground lens, which arches over, but does not touch, the cornea. Recently a special course of instruction in the technique of contact lens construction and fitting was held in Sydney. It was attended by optometrists from all the Australian capitals.

Racing Skiffs

A centre board made of plastic wood is a new invention for a racing skiff. These boards are usually of metal, and it is often a difficult task for two men to raise the heavy board without interfering with the balance of the craft. The lightweight plastic innovation is of waterproof bonded laminate, and for a 16-ft. skiff weighs only 15 to 17 lb., as against a steel centreboard of 65 lb. for the same construction. Small racing craft in Sydney have won local championships with the new board.

Hat Manufacture

Amino resins are now being used by a Sydney company to set permanently the shape of men's panama hats. The impregnated material of the hat undergoes heat treatment, after which the shape cannot be altered. The pliability of the hat is not affected by ordinary soap and water used for cleaning.

Gold Prospecting

The plastics industry has lately brought modernity to the old-established activity of gold mining in Western Australia with a prospector's dish, patterned on conventional lines, and made of black plastic. It does not require the continual blacking-over necessitated by the tin dish, and sales of the product throughout the goldfields area have been extensive.

Laminates

A Sydney company is producing new types of urea-bonded decorative laminates. A wood patterned coloured fabric is bonded to the surface of the plywood, which is then used in the form of laminated panels, table tops, and counters.

As a result of the caustic soda shortage, in Australia, the same company is now marketing an Australian-made cresylic moulding compound. Australia needs about 22,000 tons of caustic soda per year, and obtains only about 9,000 tons from local production, the balance being imported from Great Britain. Overseas supplies have practically ceased for various reasons related to world trade conditions, and the plastics industry is urging measures by the Australian Government to increase local production.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office.

F.I.A.T. Final Report 1166.—A large number of monomers were reacted with vinyl acetate under polymerizing conditions during research on vinyl acetate co-polymers at the J.G. plant at Hoechst. In general it was found that about 30 per cent. of co-monomer was necessary to significantly alter the physical properties of the basic vinyl acetate polymer. Water absorption is materially reduced by the incorporation into the molecule of increasing amounts of vinyl chloride and also vinyl benzoate. In the case of the vinyl chloride about 30 per cent. on the total weight of monomer is preferred; vinyl benzoate, 15 per cent., is likewise effective. Increased resistance of polyvinyl acetate to the action of organic solvents was brought about by co-polymerization with a maleic acid ester, i.e., diethyl maleate, followed by complete hydrolysis yielding a cross-linked polyvinyl alcohol. The addition of divinyl benzene (1 per cent.) in either bulk or emulsion polymerization was also successful, the softening point of the polymer being unaffected. Interpolymerization of acrylamide gave decreased solubility in organic solvents, but increased the water sensitivity and gave a somewhat more plastic product. Inherent brittleness of polyvinyl acetate was overcome, and film-forming characteristics improved, by co-polymerization with monomers yielding longer aliphatic residues in the side chain. The use of a fully hydrolysed polyvinyl alcohol from polyvinyl acetate of "K" 50, in amounts of 5 per cent. on the monomer, yields a product which will not coagulate on freezing and thawing.

B.I.O.S. Final Report 786.—Methods for the development and evaluation of new plastic products, as employed in certain German establishments, are outlined. The I.G. did not at any time possess a single establishment which was exclusively devoted to all aspects of research on plastics; that is, the Central Rubber Establishment at Leverkusen had no parallel in the plastics field. Full-scale production of any new product appears to have been preceded by the setting up of a special laboratory and pilot plant for that product, as in the case of Perlon U bristles at Dormagen. Appendices cover a description of the laboratories and equipment at three I.G. factories; a note on some methods for testing wood glues; and apparatus for repeated loading tests on elastomers. There are also some notes on the work which has been in progress at the Deutches Forschungsinstitüt for Kunststoffe, including the preparation of regular branch-chained linear high polymers, the effect of plasticizers on macromolecular compounds, development of silicon-organic compounds, and use of 1 : 4-butanediol in the extraction of cellulose from wood. With regard to silicon-organic compounds, a major objective of research was to obtain a better bond between the silicate and the organic glasses in armoured glass.

B.I.O.S. Final Report 857.—This general survey of the German comb industry covers 30 manufacturers of combs, raw materials, comb-making plant, and tools and dies. The general impression gained by the investigators was that no revolutionary developments in technique or machinery had taken place during the war years. In the main, methods of production were similar to those usually employed in Britain, although variations have been noted. The production of vulcanite combs appears to have ceased in 1940; simultaneously, the production of sawcut combs from celluloid and cellulose actetate sheet was dependent upon the existing stocks.

B.I.O.S. Final Report 933.—There was little new to learn from German methods of paper pulp and board moulding, the subject of this report, although Germany had developed the production of pulpware goods to a much greater extent than any other country. Paper pulp moulding methods were much the same as practised in Britain, but in the board moulding industry more attention was given to manufacturing details than is customary in Britain. Low density and very thin ply formation were considered to be absolutely necessary to obtain the best results. The German mills had no decided ideas of waterproofing other than the usual resin size or bitumen emulsion methods. No new materials were seen except in one case, where ground leather was being incorporated on hand-made boards for the manufacture of utility sole leather.

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New Mould-making Practice—for Foundries

A NEW process for making sand moulds and cores which are suitable for the production of precision castings in a wide variety of metals is described in F.I.A.T. Final Report No. 1168 (H.M. Stationery Office, price 1s. 3d.). The process is unique in its use of a plastic component which, under application of heat, bonds the sand grains together and forms a mould or core having unusual surface smoothness, high gas permeability and dimensional stability. The process is claimed to be especially suitable for the production of steel castings with very thin sections.

This new technique of precision moulding was developed by Croning and Co., Hamburg, and appears to be an important advancement in the art of metal founding. The process is especially important in that small pipe fittings, which have heretofore been cast in malleable iron only, can now be cast in steel. The moulding material used is a dry mixture of high-grade silica sand (92-94 per cent.) and a plastic binder (6-8 per cent.) in powdered form. The sand is free of clay and metal oxides, moisture and organic matter, and the grains are round and uniformly fine. The plastic binder is composed of phenolic resin (90 per cent.) and hexamethylenetetramine (10 per cent.). This binder is prepared by grinding the two materials simultaneously in a ball mill until the resulting powder will pass through a sieve having 102 mesh per inch. Dry sand and binder are then mixed in the usual manner; no water is added.

The procedure for making moulds from this material is simple, but metal patterns must always be used because they are subjected to elevated temperatures. The half-pattern, gate and runner are permanently fixed on a metal plate; cast iron is the material recommended. A set of bevelled bosses and corresponding cavities are machined at convenient spots on the pattern plates, and these shapes, when transferred to the mould halves, serve as positioners to ensure the exact registration or matching of the two halves.

The pattern unit is heated to 360-400 degrees F. and sprayed with a paraffin solution. At this temperature the paraffin remains liquid and provides a uniform, oily film. The plate is next clamped, pattern downward, over a box containing the moulding material and the assembly is quickly inverted. This action causes the moulding material to fall and cover the surface of the hot pattern and plate. The plastic component, on coming in contact with the hot metal, softens, adjusts itself to the shape of the pattern and plate, and forms a continuous coating over the entire surface. As the loose mass heats up the coating builds up, and after about 6 secs. it has a thickness of 3-4 millimetres. When the box is again turned over the excess moulding material falls away from the soft coating and may now be used for the next mould.

The pattern plate, with the adhering coating still intact, is now placed in an oven at 570 degrees F. for two or three minutes. Here the hexamethylenetetramine liberates ammonia and formaldehyde. The ammonia acts as a basic catalyst for the reaction between the formaldehyde and the unreacted phenol in the resin, resulting in the conversion of the resinous material to a hard, insoluble Bakelite-type plastic, which bonds the sand grains together. Upon coming from the oven, the half-mould is easily stripped from the pattern plate by means of lifting pins, as the thin film of paraffin acts as a lubricant.

The half-mould is, in effect, a thin shell which has enough strength and stiffness to make it suitable for the casting operation. It has the appearance of a moulded Bakelite product, except that the colour is yellow. Cores are made in much the

same manner, except that the moulding material is blown into the hot core box by compressed air. The excess material falls out of the box when the flow of air is stopped. The hollow cores have the same wall thickness as the moulds.

A mould is formed by pasting two half-moulds together; if cores are required they are assembled in the mould in the usual manner. To prepare the mould for casting, it is held in a box with the gate vertical while the surrounding space is filled in with steel shot or some other suitable bedding material. Such a bed helps the thin mould shell resist the hydrostatic pressure of the influent liquid metal.

The liquid metal is poured into the mould cavity in the usual way. The hot metal, on coming in contact with the mould, burns the plastic binder to carbon. Gases generated pass through the mould shell readily, since the mould has extraordinarily high permeability. Both mould and core offer very little resistance to the casting as it solidifies and contracts, and the danger of the formation of cracks or hot tears is minimized. The casting is easily removed from the mould, as no burning-on or sticking of sand to the casting surface occurs. Cores are removed by tapping the casting.

Among advantages claimed for this technique, the more significant are as follows: Castings are produced with clean edges, true dimensions and unchilled surfaces. The new-type moulds and cores are completely stable in respect to volume change and they are the equivalent of new permanent moulds in smoothness. Owing to the smoothness and high gas permeability of the new mould material, the casting of extremely thin sections becomes possible; cast-steel sections as thin as 1/10 in. are possible. Mould production for a given floor space can be increased four to six times. Additionally, as the moulds and cores have no affinity with water they can be stored indefinitely.

The bar and exhibition stand for the International Cocktail Competition organized by the United Kingdom Bartenders' Guild, at the Hotel, Restaurant and Catering Exhibition, at Olympia, London, was a joint enterprise of Gaskell and Chambers, Ltd., and De la Rue Insulation, Ltd., using cigarette-proof "Formica" laminated plastic. Executed to a design by S. P. Jordan, A.R.I.B.A., M.S.I.A., of the Design Section, De la Rue Insulation, Ltd., the bar itself is over 20 ft. long. Inlaid cocktail drawings in the bar front are by W. M. Dixon, A.R.C.A.

Revival of Italian Plastics Industry

by H. J. Becker

SINCE 1939, the number of Italian plants manufacturing synthetic resins and plastics has almost doubled. More than 800 factories are at present producing all sorts of plastics, as phenolics, casein, celluloid, p.v.c., urea resins, etc. The possibilities for industrial use of these products are steadily increasing and the Italian plants are working at full capacity. Furthermore, the Italian industry is not only supplying the domestic market. Before the war Italy exported fair quantities of plastics. Now that German production, once the largest in Europe, is no longer available, Italy is striving to attract some of Germany's former customers in the world market. Export, before the war amounting to about 20 per cent. of production, was considerably increased during the past year. In 1947, an export of 8,000 tons was reached, equalling one-third of the production, estimated at 18,000 tons, as compared with 12,000 tons in 1941.

Extension of Productive Capacity

Notwithstanding all efforts made before and during the war to be self-supporting, the Italian plastics industry still largely depends on imports of raw materials. In 1946, considerable quantities of benzol, phenol, coal and carbon-black were imported from the U.S.A. This year lack of raw materials is again being felt, aggravated by the forthcoming electricity restrictions as experienced also last winter. Especially scarce is the supply of basic raw materials such as benzol and phenol for the production of plasticizers, of casein and of cotton linters for celluloid. It is very doubtful whether the import of 8,000 tons of benzol, 2,000 tons of toluol and 2,500 tons of naphthalene, as planned for 1947, will have been reached.

Despite these difficulties almost all plants are working at full capacity. Some of Italy's largest steel- and iron-producing firms, such as Terni and Rumianca, are now contemplating starting production in this field. They base their plans on the fact that Italy is to-day one of the largest producers of synthetic resins and plastics.

Montecatini Company

As within the whole Italian chemical industry the Montecatini Company is leading also in this branch, both as regards technical development and market organization. The Acna Company, in Cesano Maderno, a subsidiary of Montecatini, is also one of the most important in the Italian plastics industry. With the Acna and several smaller firms the Montecatini accounts for about 45 per cent. of the present Italian production of plastics. The predominent position of Montecatini, which works many German patents, however, is gradually weakening. Similar to the development on the rubber sector, where before the war two single firms had almost a monopoly, considerable changes are taking place. Since the end of the war several new or previously rather insignificant firms have achieved considerable progress, e.g., the S.I.R. (Società Italiana Resine), Milan; the L.M.P. (Lavorazioni Materia Plastiche), Turin; the M.A.R.S. (Manufatti Resine Sintetica), Milan; the Lombardo-Polenghi, Milan; and the S.A.M.P.E.L., Milan.

Several of the Italian plastics-producing firms, and especially the Montecatini, which once had close relations with Germany, are now in contact with British and, even more, with American firms. It appears that Imperial Chemical Industries, Ltd., is more and more in the picture of the Italian plastics industry. The Italians are now making strong efforts to arrive at a vast exchange of licences with the Anglo-American competition which, it is hoped, may at once be followed by an agreement on market and price questions.

The number of Italian plastic materials is very high, and the products are used in almost every field of technology, in addition to the realms of household, sport and medicine. The research institute of the Montecatini at Novara, heavily bombed during the war, is continuously developing new materials.

Vipla, Lasto and Plexi

Before the war, the phenol resins, mainly used for insulation purposes, accounted for almost 70 per cent. of the total Italian production of plastics. Since then, however, relevant changes have taken place and about 45 per cent. of the Italian plastics production now consists of Vipla, based on calcium carbide and manufactured chiefly at Montecatini's A.C.N.A. plant at Cesano Maderno. This product, already known before the war, is similar to some foreign first-class products, e.g., Vinylite, Koroseal, Flamanol, in the U.S.A., Plastogil in France, and Igelite PCU, Mipolam and Vinifol in Germany. The flocky white powder can be easily and economically manufactured.

Vipla is of special importance to the electric industry; further, this product, highly resistant against chemical as well as mechanical agents, is widely used in other fields, e.g., for shoe-soles and tubes, for trays and basins in the chemical industry, etc. Another important part of production consists of materials the manufacture of which is based on casein, as Galalite, Galacromos, Keroid and Proteloite. Also these products are widely used, especially in the Italian button industry, which is one of the most important in the world.

This picture is completed by some three dozen other products, the use of which is also steadily rising. The most important of them are the Italian Plexiglas, Plexigum, some kinds of celluloid as Cellon and, especially, the Montecatini product Lasto, similar to the British Vulcaplas, the American Thiokol and the German Perduran. Lasto is successfully worked into tubes and insulating material. Very good results were obtained when mixed with German Buna S and Perbuna.

The lack of raw materials already mentioned has induced the Italian industrialists to look for a solution of this difficult problem.

Novelty Toy Incorporates Plastics

Small boats provided with tiny permanent magnets are manœuvred over real water on the surface of a model lake in a new toy which we have just seen. Described as the "Electro-Lake," this toy has been patented and put into production by Quin Med Research Products, of 2, Portland Road, Holland Park, W.11.

The lake, 16 ins. diameter by 3 ins. deep, is actually moulded in "Durestos," a product of Turner Brothers Asbestos Co., Ltd., Rochdale, to which reference has already been made ("Plastics," June, 1947, p. 285); the moulding pressure is 2 tons for the total area. Movement of the boats on the water is controlled by means of a remote four-way push-button switch (phenolic moulding), operating in conjunction with current from a 2-volt dry battery, which effect a magnetic field below the lake. The boats are of "Catalin," cast in moulds made with "Welvic" p.v.c. paste. The magnets, of cobalt steel, are fixed to the boats in form of keel and foremast.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Plastics for Water Pipes

Sir,—We were interested to see your editorial comments in the November issue regarding the use of polyvinyl chloride compounds as replacements for lead pipes for domestic and industrial applications.

We feel that p.v.c. cannot lightly be discarded for such applications as all plasticized material does not suffer from the defect you mention, namely, evaporation or extraction of the plasticizer. We have in mind in making this statement the new Geon polyblends which are plasticized vinyl resins containing as plasticizer a butadiene - acrylonitrile copolymer, which is, of course, completely non-volatile and is virtually non-extractable in common solvents. Such compounds can be made in a very wide range of hardness and are, we feel, likely to be useful for the purpose you mention in your article.

S. J. SKINNER,
British Geon, Ltd.
Abbey House,
Baker Street, London, N.W.1.

Protection Against Corrosion

Sir,—We are faced, at the moment, with a problem in our Packaging Department which we believe can best be solved by the use of plastics, and we should be grateful if you would let us have your suggestion, based on the following information.

Amongst our products, we are manufacturers of a number of engineers' small tools and items of machine tool equipment, which are finished to a high degree of accuracy, and which are particularly susceptible to corrosion. It has been our practice for a long time to have these tools, which mostly are of ground steel, dipped in a cleansing bath, such as trichlorethylene, then to apply by brush a coating of rust-preventative grease, and finally to wrap in grease-proof paper. Small parts are then packed in gross or dozens, these boxes being chiefly for display purposes.

We are aware that certain manufacturers of allied products, for instance, Hall and Pickles, of Sheffield, and The Birmingham Tool Co., Ltd., are using some form of "skin" which appears to be plastic. We have been trying for a long time to find a source of supply of some such material, preferably for application by dipping, and we had originally in mind the ethyl cellulose process as used by Service Departments through the War. We are led to understand by our friends in the chemical world that this material cannot be produced over here in view of the shortage of certain vital constituents.

We have tried several forms of waxes, at least one of which we understand had some plastic content, but these coatings have not the mechanical strength which we require, or, alternatively, are liable to crack, particularly when they are applied to articles having an oil or grease film.

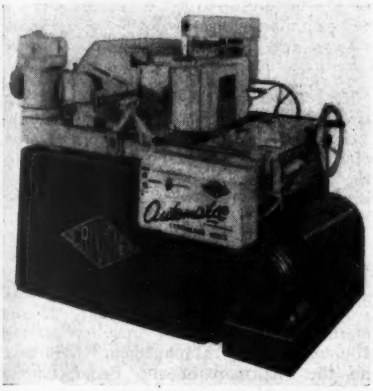
A. A. JONES AND SHIPMAN, LTD.
Narborough Road South,
Leicester.

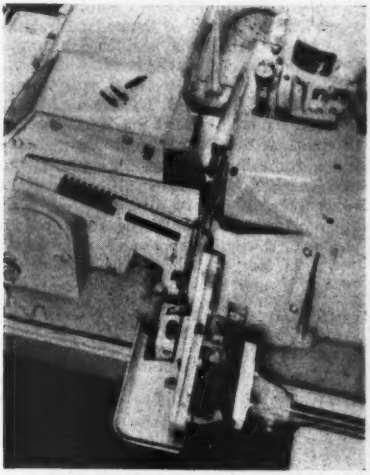
EDITOR'S NOTE: We are glad to inform the inquirers that not only is ethyl cellulose available in this country, but also that the special compound containing it for the dipping process (so widely used in the war for the protection of valuable tools against corrosion) is available from BX Plastics, Ltd., Higham Station Avenue, London, E.4. In this process the object is dipped into the hot mixture maintained at a predetermined temperature (about 180-190 degrees C.). On removal, the coating solidifies almost immediately and can be stripped off quite easily; it is comparatively thick.

An entirely different method of metal protection which should also prove of interest is that known as "Birlon," which we describe in this issue on page 59. Primarily intended for the protection of highly polished metal sheets, especially during pressing, it is applied by spraying and dipping, the resultant film being about 0.001-0.002 in. thick.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes





Centreless grinding machine, showing magazine for feeding fountain-pen sections (Arthur Scrivener Ltd.).

FOUNTAIN-PEN MANUFACTURE.—Our illustrations show the latest controlled-cycle machine of Arthur Scrivener, Ltd., Tyburn Road, Birmingham, as used for the centreless grinding of fountain-pen nib sections, including a detail view of the magazine for feeding the pieces to the machine. By means of such an installation, the sections in question (or other pen parts) can be ground at rates up to 800 pieces per hour entirely automatically, the function of the operator being merely to keep the magazine filled with blanks.

Fountain-pen nib sections are ground from the blank with a stock removal on each piece of 0.108 in. maximum. It is claimed that the use of the centreless grinding process for finishing the various components will be the means of effecting a minor revolution in manufacturing costs in the fountain-pen industry.

MOULDING DIFFICULTIES.—British Industrial Plastics, Ltd., have reprinted in booklet form Nos. 1 to 12 of their series of announcements, "Leaves from a Moulder's Notebook," which have been appearing in "Plastics." This booklet of 36 pages should prove widely of interest to all those concerned with the practical side of moulding, especially where teething and production problems are encountered. It deals with flow marks, transfer moulding, insulating by water flow, ribs, moulding abrasion, air vents, H.F. preheating, moulded hinges, and expansion. The notes have been written by B.I.P.'s development engineer, Mr. J. Butler, A.M.I.Mech.E. Copies are obtainable from British Industrial Plastics, Ltd., 1, Argyll Street, London, W.1.

BUTTON MANUFACTURE.—A prominent place at the forthcoming British Industries Fair, May 3-14, is to be occupied by a Casein-Button Group Display in the Fancy Goods Section of the Fair at Olympia. Apart from the information bureau of the Casein Joint Development Council, there are to be stands of the casein products manufacturers on each side of one of the main promenades. Each stand will be designed distinctively to preserve the individual characteristics of the exhibiting firms. It is understood that the B.I.F. authorities are giving all assistance in making it possible to present "the case for the British button" to buyers who will be visiting the 1948 Fair. In the unity of the British button manufacturers, symbolized by the Casein Plastics

Joint Development Council, lies the strength to overcome difficulties. At present it appears that only one button in every twenty in the world is British made. There may never come the day when all buttons in the world are British, yet the British manufacturers are determined that the time will come when the majority of buttons are British, leading, perhaps, to a goal of 5,000 million British buttons a year!

AERO RESEARCH, LTD., which has for some years held from Ciba, Ltd., the rights of manufacture of melamine formaldehyde resins for adhesives and the like, has now concluded arrangements with Ciba, Ltd., covering a number of novel plastics, including melamine formaldehyde resins for textiles, wet strength paper, and other applications, as well as the new metal-to-metal adhesive and casting resin known as "Araldite."

BRITISH INDUSTRIAL PLASTICS, LTD., is increasing the dividend on its £579,891 ordinary shares from 12 per cent. to 20 per cent., less tax, for the year ended September 30, 1947. The dividend is payable on April 7. Gross profit has risen from £391,146 to £506,469. After deducting expenses, pensions and directors' fees and providing £74,213 (£20,944) for depreciation, £22,611 (£24,809) for research and development and £142,000 (£156,000) for taxation, net profit amounts to £79,296, against £44,512 for 1945-46, an increase of £34,784. Carry forward is £26,448 (£15,959).

BRITISH MOULDED PLASTICS, LTD., held a Christmas party for children of their employees on December 22, when 625 children were present at the new Assembly Hall, Walthamstow. This is the second occasion on which the children's Christmas party has been held.

LACRINOID PRODUCTS, LTD., propose to increase the company's capital to £250,000 by creating 1,000,000 shares of 2s. each, partly to allow for the acquisition of another business. It is intended to purchase the entire capital of Insulation Equipments, Ltd., of Oswestry.

NEW YEAR HONOURS.—The British plastics industry was recognized in the New Year Honours List with the appointment of Mr. F. J. Robinson as a Member of the Order of the British Empire. Mr. Robinson is director and general works manager of Bakelite, Ltd., with which company he has been associated from the earliest days.

LIGNIN POWDER.—The Arborite Co., Ltd., of 1235 McGill College Ave., Montreal 2, Canada, has been incorporated to take over the operations of the Plastics Division of Howard Smith Paper Mills, Ltd., as from January 1, 1948. The company's concessionnaires in Great Britain for the sale of Tomlinite lignin powder are R. H. Cole and Co., Ltd., 2, Caxton Street, Westminster, S.W.1.

MR. G. L. BARRON, A.I.R.I. (Sc.), sales director for Clear Glass Products, Ltd., and Barron Bros., of Southampton, will be making a business visit to Scandinavia, Holland and Belgium at the end of February.

NOTES FROM BRITISH PLASTICS FEDERATION

Moulders' Group

The Midland Sub-section of the Moulders' Group held a meeting on January 12 and entertained a number of members of the Moulders' Group Management Committee and the chairman of the Federation to luncheon. About 60 members and guests were present.

Plastic Bowls and Dishes

As a result of representations by the Federation to H.M. Customs and Excise the Commissioners of Customs and Excise have decided that the criteria for determining the liability to tax of certain glass bowls and glass dishes, announced January 5, 1948, may be applied, with effect from January 21, 1948, to similar bowls and dishes of plastic material, under the same conditions, so far as they are applicable.

It was on the advice of the Glass Manufacturers' Federation and the Glass and Allied Trades' Association that the Commissioners of Customs and Excise decided that, with certain exceptions, open (i.e., unlidded) glass bowls and glass dishes of the dimensions set out below should be regarded as articles not normally used otherwise than in the preparation or serving of food or drink and therefore exempt from purchase tax. The decision applied to open bowls and dishes of all shapes, whether supplied singly or in sets, including bowls and dishes with feet which form integral parts of the bowls or dishes. Regarding dimensions, the external width, measured horizontally from outside edge to outside edge at the widest part (including projecting rims, ledges, lips and flanges), is not to exceed 11 ins.; internal depth, measured vertically to lowest point of rim, to be not less than one-fifth or more than one-half of the width.

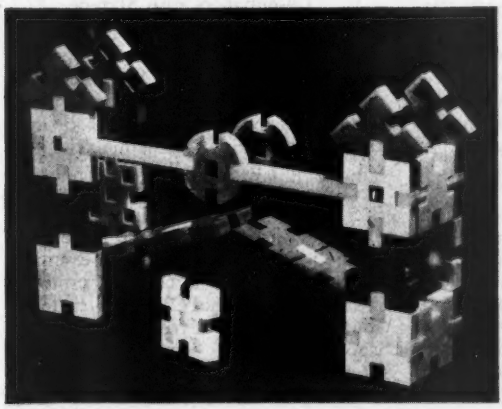
New Productions from the Moulding Shops

Injection-moulded Brooch

This amusing and excellently executed brooch has been injection-moulded from cellulose acetate by Principality Plastics, Ltd., of Bute Street, Cardiff; the moulding is subsequently embellished by hand-painting.

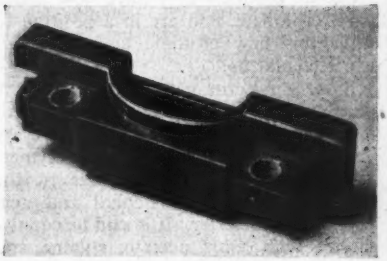
Toy for Model-making

A new toy has appeared on the market from Abbey-Corinthian Games Co., of 22, Oakleigh Park North, Whetstone, London, N.20. It is of the "building-up" interlocking type so well loved by boys up to the age of 70, and it possesses many interesting points. There are 34 main or basic units and a number of accessory rods and links, so that a very large variety of structures ranging from toy ships to bridges and trucks can be built up. The main units are of cellulose acetate, but the rods and links appear to be of polythene, the latter being chosen probably in order to get a frictional fit. Our illustration shows a structure resembling the Tower Bridge, London. This "Makimor" toy is injection moulded by Capp Plastics, 1, Goding Street, London, S.E.11, using a 4-oz. Reed-Anderson machine. The high-precision moulds were made by G. F. Hughes, Ltd., 305, Hither Green Lane, London, S.E.13.



Transfer-moulded Fuse Bridge

This 15-amp. fuse bridge is being made by Stafford Plastics, Ltd., Gordon Mills, Stafford, using a 4-impression transfer tool.



Exposure Meter

Polystyrene lens is said to increase the photometric efficiency of the General Electric Co.'s new photographic exposure meter. This new meter contains a pointer-locking mechanism which "remembers" to shift the meter automatically from high light to low and back again as the scene requires. Designed in cylindrical form with only a slight curvature of the axis, the lens improves distribution of light on the surface of the photo-cell and thereby increases its response to the light flux from a given solid angle. Other plastic parts include a scale plate window of methyl methacrylate, a black phenolic case for the meter and a laminated regulator. The case is made of a cotton-flock phenolic compound developed during the war. Four different plastics are therefore used for the component parts of this particular photographic accessory.

Vinyl and Allyl Crotonates— New Materials for Plastics

THE position of Shawinigan Chemicals, Ltd., as a low-cost producer of synthetic organic chemicals on a large scale is unique. Originally known as Canada Carbide, they were the first of the world's chemical manufacturers to use acetylene as raw material for a range of products which not only included acetic acid and acetone, but also butyl, ethyl, amyl and vinyl (1917) acetates, the latter subsequently leading to vinyl resins. To their range of products they have now added vinyl crotonate, and are in a position to offer this new crotonic acid ester for experimental use.

Since vinyl crotonate has never before been offered commercially, the uses for it as described in scientific literature are scanty. It is suggested for copolymerization work, taking advantage of the unsaturation of both alcohol and acid portions of the ester. It is said to copolymerize with vinyl acetate, styrene and other monomers to produce polymers of higher melting points, with greater resistance to solvents, and which are more suitable as moulding compounds due to their decreased temperature sensitivity and thermosetting characteristics. As such, it is therefore likely to be of immediate interest to the plastics industry.

A survey of possible applications has been prepared by Shawinigan's Department of Chemical Development, from which the following notes have been taken. In this survey the manufacturers have also included certain data for allyl crotonate, as, by analogy, they expect allyl and vinyl crotonates to display similar properties.

Regarding the addition reactions of vinyl crotonate, bromine absorption is found to be a time reaction, and is about 99 per cent. complete in 30 mins. The addition to the crotonate double bond appears to be less rapid than to the vinyl double bond. The addition of sodium hypobromite to the two double bonds takes place quantitatively.

POLYMERIZATION.—It has been found that pure vinyl crotonate went solid after 60 hrs. in the mercury arc, with a slight volume shrink. The condensed body after boiling out was hard and brittle and could be powdered in the fingers.[1]

For the production of transparent sheets, a fusible heat-convertible polymer of a compound, which in its monomeric form contains at least two polymerizable double bonds, such as methallyl crotonate, is moulded, and the surface of the moulded product, which may be in the form of sheets, is further polymerized to a hard, substantially infusible state while simultaneously polymerizing the interior to a substantially lesser extent.

Example: A quantity of fusible allyl crotonate polymer containing 3 per cent. benzoyl peroxide was placed on a mould between a pair of platens (one of which was heated to 165 degrees C., while the other was kept at 30 degrees C.) under a pressure of 5,000 lb. per in. for 10 mins. A product having one soft surface and one hardened surface was secured. This process was repeated, using polyvinyl crotonate prepared by esterification of polyvinyl alcohol with crotonic acid and 5 per cent. catalyst.[2]

Co-polymers with Styrene

VINYL POLYMERIZATION PRODUCTS.—One or more hydrocarbons of the group comprising styrene and its homologues can be polymerized by heat, light or catalysts in the presence of one or more esters of crotonic or cinnamic acid. The catalyst may be a small quantity of a free unsaturated acid and the heating may be in a sealed tube containing inert gas, for example, nitrogen, or in the presence of an inert solvent or diluent. In examples, styrene is heated with (1) hexyl crotonate in isopropylbenzene, (2) benzyl crotonate containing a trace of free crotonic acid in isopropylbenzene, and (3) benzyl cinnamate.

Example: Vinyl crotonate - styrene

co-polymer. A mixture of 150 c.c. of monomeric styrene (99 per cent.) and 2 c.c. of vinyl crotonates were heated in a sealed glass tube under nitrogen for 40 hrs. at 104 degrees C. The clear, hard resinous product was thermoplastic, but was not truly soluble in benzene, in which it formed a gelatinous mass.[3]

A mixture of monomeric styrene and rubber may be heated with a crotonic ester; α-alky styrene can be present, for example, α-methyl. Suitable crotonic esters are vinyl crotonate and ethylene glycol dicrotonate. The polymerization is best effected in the absence of air. The rubber can be in latex form. The resulting products are less thermoplastic, but tougher and more rubber-like than products derived merely from rubber and polystyrene.

POLYMERIZATION OF STYRENE-TYPE COMPOUNDS.—Products suitable for hot moulding are produced by subjecting a mixture of styrene and styrene polymers to polymerizing conditions (suitably for 24 hrs. in nitrogen at 115 degrees) in the presence of vinyl crotonate or other ester of crotonic acid having at least two double bonds in the molecule separated by at least one C atom, until substantially complete polymerization is effected.

Example: 100 c.c. of monomeric styrene of 97 per cent. by weight purity (the remaining 3 per cent. consisting of saturated hydrocarbons, such as isopropyl benzene), were heated in an atmosphere of nitrogen for 24 hrs. at 105 degrees C. until about 70 per cent. by weight of the monomer had been polymerized; 0.5 c.c. of vinyl crotonate was then added and polymerization was continued for 24 hrs. at 115 degrees C. After raising the temperature to about 160 degrees C. and removing non-polymerizable constituents by distillation under reduced pressure, 91 grams of a transparent resin were obtained, having a molecular weight of 185,000; the resin was thermoplastic and was soluble in benzene.[5, 6]

Synthetic resins suitable for use in moulding, laminating, casting, coating and for adhesive application, are prepared by mixing an ester of crotonic acid with an esterification product of a polyhydric alcohol and an α, β-unsaturated polycarboxylic acid, and subjecting the mixture to heat or light to effect interpolymerization.[7]

Co-polymers of vinyl compounds and unsaturated allyl esters and ethers, which are suitable for sheets, tubes, rods, etc., are obtained by polymerizing a compound such as vinyl acetate (containing the polymerizable group $=C=CH_2$ and no other polymerizable group) in the presence of about 0.1 per cent. or more of allyl crotonate or other aliphatic compound containing an allyl group and one additional polymerizable double bond separated therefrom at least by an oxygen atom and not containing more than three oxygen atoms in the molecule.[8]

Allyl Crotonate

A substantially infusible, insoluble polymer suitable for production as a coating or impregnating material is prepared by a method which involves polymerizing an unsaturated alcohol ester of crotonic acid, such as oleyl, methallyl or allyl crotonate, and interrupting polymerization after substantial polymerization has occurred but before the polymer is converted to a gel. The residual monomer is completely separated from the resulting polymer before the latter is polymerized to an infusible state. The polymer is subjected to a temperature and pressure sufficient to insure existence in a fused state, and polymerization of the fused polymer is continued for a time sufficient to convert it into an insoluble, infusible state.

Example: A quantity of monomeric allyl crotonate was heated in a stream of air at a temperature of 150-160 degrees C. until the solution became viscous. The liquid was then cooled to room temperature and distilled at an absolute pressure of 1 millimetre of mercury until a solid mass remained. This material was fused by heating to a temperature of 100 degrees C. in a mould and was further cured at a pressure of 1,500 lb.

per sq. in. and a temperature of 150 degrees C. for one hour. The article produced was hard, insoluble, clear, transparent and free from fractures.[9]

Interpolymerization products of allyl crotonate and unsaturated alkyd resins are suitable for coatings or moulded articles. They are formed from allyl crotonate and at least one unsaturated alkyd resin.

Example: Allyl crotonate, 10 parts, and diethylene glycol maleate, 90 parts, yielded a hard, tough, insoluble and infusible interpolymer when co-polymerized for 2 hrs. at 80 degrees C. in the presence of 0.5 part benzoyl peroxide. When the proportions of allyl crotonate and diethylene glycol maleate were reversed, a white, opaque, non-flowing gel was obtained after 24 hrs.' heating at 80 degrees C. and a fairly hard gel with rubbery characteristics after heating for 144 hrs.[7,10]

Co-polymers with Vinyl or Vinylidene Compounds

To illustrate the variation in properties of co-polymers of vinyl compounds and unsaturated allyl esters and ethers, vinyl acetate may be mixed with 1/25th, 1/10th, 1 and 3 per cent. of allyl crotonate, 1 per cent. of benzoyl peroxide being added in each instance, and heated in completely filled iron flasks for 90 hrs. at 35 degrees C., the soft, flexible polymers being removed from the flasks and hardened by heating in air for 15-30 mins. at 100-120 degrees C.

A product prepared in this manner from vinyl acetate alone is hard at room temperature, but is so soft at 120 degrees C. as to be almost liquid, and is easily soluble in acetone. The products containing allyl crotonate are equally hard at room temperature, but much less plastic and soluble, the product containing 1/25th per cent. being a soft plastic at 120 degrees C. and dissolving slowly in acetone. The product containing 1/10th per cent. being still plastic at 120 degrees C., but only partly soluble in acetone; those containing 1 or 3 per cent. are elastic but not plastic at 120 degrees C., and swelling somewhat in acetone without dissolving.[11, 8]

REFERENCES

(1) *Shawinigan Chemicals Ltd., unpublished reports, C. C. Coffin,* 1927. **(2)** *U.S.P.* 2,318,959 (1943), *I. E. Muskat, M. A. Pollack. F. Strain and W. A. Franta, to Pittsburgh Plate Glass Co.* **(3)** *B.P.* 494,575 (1938), *Distillers Co. Ltd., H. M. Stanley and H. P. Staudinger.* **(4)** *B.P.* 530,375 (1940), *Distillers Co. Ltd.* **(5)** *B.P.* 533,174 (1941), *Distillers Co. Ltd.* **(6)** *U.S.P.* 2,330,527 (1943), *H. P. Staudinger, to Distillers Co. Ltd.* **(7)** *B.P.* 547,328 (1942), *British Thomson-Houston Co. Ltd.* **(8)** *U.S.P.* 2,265,640 (1941), *B. S. Garvey and C. H. Alexander, to B. F. Goodrich Co.* **(9)** *U.S.P.* 2,306,139 (1942), *M. A. Pollack, to Pittsburgh Plate Glass Co.* **(10)** *U.S.P.* 2,260,005 (1941), *G. F. D'Alelio, to General Electric Co:* **(11)** *U.S.P.* 2,202,846 (1940), *B. S. Garvey and C. H. Alexander, to B. F. Goodrich Co.*

CELLULOSE ACETATE PLASTICS

(*continued from page* 69.)

Mottles can be simply made by blending two batches of stock of different viscosity and different colour at the rolling stage and then pressing as before. Another method is to drop dice cut from a blanket of one colour into stock of another colour whilst on the rolls, again followed by sheeting and pressing, etc. This type of treatment, however, can only produce simple and comparatively uncontrolled colour effects. In some cases alternate sheets of different colours are pressed together, sliced, and the sliced sheets cut down and stacked on end and rewelded into a block.

For moire-type variations, the block would then be cut, restacked and welded for a third time. Grained-ivory finishes can be made by welding a block made up of alternate thin hides of different shades of ivory, followed by slicing, cutting down, stacking vertically and rewelding. Finishes such as imitation mother-of-pearl and tortoiseshell are easy to make when only a rough imitation is required, but to produce a really first-class sheet, closely resembling the natural product, great skill is required; the exact method of producing these materials is kept a close secret.

(*To be continued.*)

Health Hazards for P.V.C. and Acrylics?

Some medical aspects of handling rubber and plastics, in manufacture or in use, are surveyed by Dr. George Blaine, of the Strangeways Research Laboratory, Cambridge, in the issue of "Chemical Products" for Nov.-Dec., 1947. By kind permission of that journal we give the following extracts.

THE basic property to be considered from the medical point of view for any material which is in contact with human tissues, or to which such tissues are exposed, is the reaction elicited by it. A material can be safely handled or used only if it is proved by suitable experiments that it does not give rise to toxic reactions. If the material is both indispensable and somewhat toxic, precautions have to be devised to minimize damage to health.

The fact that rubber manufacture is subject to the Dangerous Trades Regulations under Section 60 of the Factories Act is due to the solvents and accelerators which are used.

Skin irritation and resulting dermatoses are the most common sequels of exposure to these solvents and accelerators. The toxicology of handling polyvinyl compounds is similar to that of rubber processing. Processing shops in the plastics industry, however, are, on the whole, of newer design than rubber factories and the hazard of dustborne irritants and fumes is therefore reduced.

An investigation of polyvinyl chloride compounds in the course of the last year revealed that the majority of well-cured and produced products have a good tissue tolerance. The tissue reaction elicited by polyvinyls is always a local one; it is marked by a defensive reaction on the part of the tissue into which it is embedded. Material containing no dye elicited the least amount of tissue reaction. The dyes and plasticizers used separately in control experiments, were strong protoplasmic poisons. The tissue reaction thus depends definitely on the contents of the plastic mix.

Polyvinyl chloride is extensively used in the production of anæsthetic airways, etc., in medical practice. Stoppers of penicillin solution containers can also be made in p.v.c. provided the least reactive type of material is used; with some polyvinyl stoppers rapid loss of penicillin potency has been recorded.

The hazards of manufacture for acrylics are of a different kind. The methyl methacrylate monomer is a strong respiratory irritant, and good ventilation is essential to reduce the risk of exposure. In larger concentrations it may cause irritation and inflammation of the respiratory passages. Inhaled, it may act as a narcotic and convulsant. Persons not used to it are liable to get headaches when exposed to minimal concentrations. It has little local action on the skin and few cases of dermatitis are on record. The polymer, however, produces no reaction whatsoever.

Methyl methacrylate is used on a large scale in dental laboratory practice. Since the dental technique involves handling and mixing into a doughy or paste-like mass, and is a process often done by hand, the lack of cases of dermatitis is good evidence of its non-toxicity. In animal experiments, too, acrylic plastic was found to be the least irritant of all plastics, creating only a minimal tissue reaction; there is no reaction from the fully polymerized material.

Further evidence of the non-toxicity of methyl methacrylate is afforded in brain surgery with a new method of using this plastic. Monomer and polymer mixed in suitable proportions, rapidly become tacky and soon after become fully plastic, in which stage the mixture can be moulded. This whole process can be done under sterile conditions,

(*Continued on page* 108.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 592,716. Application date: 19.4.45. Accepted: 26.9.47.

Improvements in Packages. A. G. Rose and J. A. Fitchett. To: Rose Brothers (Gainsborough), Ltd.

B.P. 592,746. Application date: 19.4.45. Divided out of B.P. 592,716. Accepted: 26.9.47.

Improvements in the Packaging of Articles. A. G. Rose, J. H. Fitchett. To: Rose Brothers (Gainsborough), Ltd.

B.P. 592,757. Application date: 31.10.44. Patent of addition to B.P. 568,802. Accepted: 29.9.47.

Improvements in or relating to Composite Materials. R. J. F. Ubaghs.

Manufacture of flooring, furniture, etc., by impregnating stalks of twigs with a methylol urea or phenol formaldehyde resin and subsequent pressing until a firm bond is achieved.

B.P. 592,762. Application date: 4.4.45. Accepted: 29.9.47.

Improvements in or relating to the Manufacture of Containers, Receptacles, Hollow Ware or the like from Resin-impregnated Laminations. Sir S. S. Bhatnagar, A. R. Khan and L. C. Verman. To: Council of Scientific and Industrial Research, Delhi.

B.P. 592,801. Application date: 1.8.44. Convention date (U.S.A.): 23.8.43. Accepted: 30.9.47.

Improvements in Electrical Bonding Apparatus. Radio Corporation of America.

Electric welding machine for very wide sheets of plastic consisting of a work table with a strip-type spring-loaded or roller electrode. The oscillator and top electrode roller are combined in a unit which travels overhead and has no physical connection with the work table.

B.P. 592,807. Application date: 30.3.45. Accepted: 30.9.47.

Plastic Moulding Machines. A. A. Burry.

B.P. 592,836. Application date: 4.6.45. Convention date (Belgium): 16.3.43. Accepted: 30.9.47.

Improvements in or relating to the Manufacture of Water Swelling Films. British Sidac, Ltd.

Water and moisture proofing of regenerated cellulose films by applying a coating which consists of a solution of rubber and a maleic anhydride compound. The excess of solvent is subsequently removed. Additional coatings consisting of varnish or waxes may also be applied.

B.P. 592,867. Application date: 15.3.45. Convention date (Canada): 29.9.44. Accepted: 1.10.47.

Production of Styrenes and Other Products. Dominion Tar and Chemical Co., Ltd.

Production of styrene, etc., by molecular decomposition of asymetric diaryl substituted paraffins and from benzol still residues in particular.

B.P. 592,913. Application date: 7.6.45. Convention date (U.S.A.): 11.8.44. Accepted: 2.10.47.

Emulsion Polymerization of Butadienes. C. E. Barnes. To: General Aniline and Film Corp.

B.P. 592,960. Application date: 25.4.45. Accepted: 2.10.47.

Improvements in or relating to the Welding together of Sheets of Thermo-plastic Materials. G. Haim and H. P. Zade.

High-frequency welding of films or sheets consisting of materials which have a low loss angle (e.g., polythene or polyisobutylene). Welding is effected by interposing between the electrodes of a high-frequency generator and the sheets to be welded one or several films of a material with a high loss angle; for instance, polyvinyl chloride. The latter becomes hot due to dielectric heating and the heat so produced is dissipated into the polythene or polyisobutylene. Pressure is simultaneously exerted to effect bonding.

B.P. 593,011. Application date: 11.6.45. Accepted: 6.10.47.

Improvements in or relating to a Process for Multi-colour Printing on Sheet Material and to Articles produced thereby. W. A. Huizinga. To: P. B. Cow and Co., Ltd.

B.P. 593,036. Application date: 6.2.45. Accepted: 7.10.47.

Modified Olefinic Copolymer. To: Standard Oil Development Co.

Refers to sulfo-chlorinated polymers which are particularly effective as softeners for rubber and the like.

B.P. 593,072. Application date: 10.9.42. Accepted: 8.10.47.

Improvements in or relating to Plastic Compositions. J. J. P. Staudinger and H. M. Hutchinson. To: The Distillers Co., Ltd.

Manufacture of a plastic composition by incorporating a synthetic rubber (polyethylene, polyisobutylene, polybutadiene, polyisoprene, etc.) into a copolymer having an aromatic or heterocyclic ring, with a cross-linking agent in an amount such that the copolymer has reduced solubility characteristics.

B.P. 593,079. Application date: 9.11.44. Accepted: 8.10.47.

Improvements in or relating to the Manufacture of Moulded Articles from Coal. G. C. Philpotts, M. Pirani, A. Buirski, and J. G. Bennett. To: C. D. Patents, Ltd.

The manufacture of moulded articles from coal has already been disclosed in B.P. 561,498 or 561,546. The present invention refers to improvements achieved by firing these articles under non-oxydizing conditions at a temperature above that at which they were moulded.

B.P. 593,090. Application date: 27.3.45. Convention date (U.S.A.): 15.11.44. Accepted: 8.10.47.

Coated Paper. To: Wingfoot Corporation.

Preparation of a water vapour resistant surface on porous paper by coating the paper with polyvinyl chloride and subsequent treatment of the coated paper with a solution of vinylidene chloride (40-80 per cent.) and vinylchloride (60-20 per cent.) in an aromatic hydrocarbon.

B.P. 593,091. Application date: 6.4.45. Convention date (U.S.A.): 6.4.44. Accepted: 8.10.47.

Improvements in or relating to Modified Polymeric Materials. To: Imperial Chemical Industries, Ltd.

Manufacture of modified polymeric materials by intimately mixing and reacting a N-alkoxymethyl polyamide (N-methoxymethyl polyhexamethylene adipamide) with a substance containing a plurality of alcoholic hydroxyl groups.

B.P. 593,097. Application date: 15.5.45. Convention date (U.S.A.): 15.5.44. Accepted: 8.10.47.

Improvements in and relating to Poly-N-Vinyl Carbazole Products. To: The British Thomson-Houston Co., Ltd.

B.P. 593,111. Application date: 7.6.45. Accepted: 8.10.47.

Improvements in and relating to the Manufacture of Resinous Condensation Products. W. Blakey, A. Brookes, and F. L. Hudson. To: British Industrial Plastics.

Relates to urea formaldehyde condensates particularly useful in papermaking.

B.P. 593,152. Application date: 12.3.45. Convention date (U.S.A.): 15-4-44. Accepted: 9.10.47.

Improvements in or relating to Synthetic Rubber of the Butadiene-Styrene Type and a Method of Coagulating a Dispersion thereof. R. L. Bebb. To: The Firestone Tire and Rubber Co.

B.P. 593,240. Application date: 25.5.45. Convention date (U.S.A.): 25.5.44. Accepted: 13.10.47.

Process for the Production of Film consisting essentially of a Tetrafluoroethylene Polymer. To: E. I. Du Pont de Nemours and Co.

Production of polytetrafluoroethylene film by pressing finely divided powder into a preform, baking the latter at a temperature between 327 degrees C. and 500 degrees C., until it is sintered, cooling the preform, separating the film and heating it again to a temperature between 327 degrees C. and 500 degrees C. and finally quenching the film in a liquid which is inert to the polymer.

B.P. 593,286. Application date: 11.6.45. Convention date (U.S.A.): 12.6.44. Accepted: 13.10.47.

New and Useful Copolymers Derived from Tetrafluoroethylene and other Halogenated Ethylenes. To: E. I. Du Pont de Nemours and Co.

B.P. 593,313. Application date: 13.6.45. Convention date (U.S.A.): 14.6.44. Accepted: 17.10.47.

Improvements in or relating to the Coating of Articles with Synthetic Resins. To E. I. Du Pont de Nemours and Co.

Relates to the coating of articles with compositions which consist essentially of a mixture of a polyvinyl acetal resin and polythylene.

B.P. 593,372. Application date: 15.3.45. Accepted: 15.10.47.

Improvements in or relating to Liquid Synthetic Resinous Adhesive Compositions. L. R. Anthony, B. Frenkel, C. E. Smith and R. W. H. Wicking. To: British Resin Products, Ltd.

Water resistant crack-free urea-formaldehyde adhesive containing phenol. In the course of curing, the phenol combines with the urea-formaldehyde.

B.P. 593,445. Application date: 16.5.45. Convention date (France): 25.1.43. Accepted: 16.10.47.

Improvements in or relating to Polyvinyl Chloride Compositions. To: Société des Usines Chimiques Rhône-Poulenc.

Refers to polyvinyl chloride compositions plasticized with di-(methoxyethyl) adipate which are particularly suitable for shoe soles and waterproof garments.

B.P. 593,458. Application date: 13.7.43. Convention date (U.S.A.): 14.7.42. Accepted: 17.10.47.

Improvements in and relating to Alkyd Resin Varnishes. To: The British Thomson-Houston Co., Ltd.

Varnish compositions comprising an alkyd resin and the resinous product obtained by heating an aryl substituted guanazole and formaldehyde or a compound capable of producing formaldehyde when heated.

B.P. 593,475. Application date: 2.11.44. Convention date (U.S.A.): 3.5.44. Accepted: 17.10.47.

Pimelic-Acid Esters and Polymers. To: Wingfoot Corporation.

B.P. 593,477. Application date: 23.11.44. Convention date (U.S.A.): 23.2.44. Accepted: 17.10.47.

Improvements in Vulcanized Furfuryl Alcohol Resins. To: Arthur D. Little Incorporated.

Preparation of vulcanized products by heating furfuryl alcohol under the influence of an acidic polymerization catalyst and mixing the polymer with sulphur or sulphur containing vulcanizing agents and subsequent heating. The products so obtained are resistant to hydro-carbons, salt water, steam and boiling water.

B.P. 593,519. Application date: 22.5.45. Convention date (U.S.A.): 14.11.44. Accepted: 20.10.47.

Copolymers of Dimethyl Styrenes. E. L. Kropa. To: American Cyanamid Co.

B.P. 593,531. Application date: 1.6.45. Accepted: 20.10.47.

Improvements in and relating to the Moulding of Plastic Materials. F. E. Wall.

B.P. 593,547. Application date: 4.6.45. Convention date (U.S.A.): 6.6.44. Accepted: 20.10.47.

Compositions comprising Cellulose Derivatives and N-Alkoxy-Methyl Polymides. E. I. Du Pont de Nemours and Co.

B.P. 593,605. Application date: 8.6.45. Convention date (U.S.A.): 8.6.44. Accepted: 21.10.47.

New and Useful Copolymers Derived from Fluorinated Ethylenes and Chlorotrifluoroethylene. To E. I. Du Pont de Nemours and Co.

B.P. 593,625. Application date: 12.6.45. Convention date (U.S.A.): 14.6.44. Accepted: 22.10.47.

Improvements in and relating to Moulded Fibre Products: To: The British Thomson-Houston Co., Ltd.

Fibrous products made by forming a suspension of a mixture of comminuted materials comprising cellulosic fibres which have been rendered water repellant by treatment with organohalogenosilanes and subsequent deposition of the suspended matter on a foraminous form.

B.P. 593,677. Application date: 6.7.43. Accepted: 23.10.47.

Improvements in the Surface Treatment of Plastic Materials. J. J. P. Staudinger and H. M. Hutchinson. To: The Distillers Co. Ltd.

Surface treatment of plastic sheets (methyl methacrylate, acrylic esters, vinyl esters) to render them hydrophilic by treating said surfaces with the vapour of fuming sulphuric acid, sulphur trioxide, etc., for a short period, and subsequent washing with an inert solvent until neutral. This treatment improves also adhesion of glues, etc., to the plastic.

B.P. 593,699. Application date: 28.11.44. Accepted: 23.10.47.

Improved process for the Production of Olefinic Polymers. To: Standard Oil Development Co.

B.P. 593,700. Application date: 1.12.44. Convention date (U.S.A.): 18.3.44. Accepted: 23.10.47.

Cellular Zein Boards. To: United States Rubber Co.

B.P. 593,744. Application date: 18.7.44. Accepted: 24.10.47.

Improved Process and Apparatus for the Low Temperature Polymerization of Olefins. To: Standard Oil Development Co.

B.P. 593,786. Application date: 16.12.44. Accepted: 24.10.47.

Improved Devices for Removing Products from Plastic-Moulding or Die-Casting Machines or other Presses. F. J. Lupton, G. M. Turner. To: Fox and Offord Ltd. and V. and E. Plastics Ltd.

B.P. 593,788. Application date: 15.6.43. Accepted: 27.10.47.

Improvements in Process for Producing

Polymeric Materials. J. C. Cowan and W. C. Ault.

Rubber-like polymers produced by heating polyesters of dihydric alcohols and polymeric fatty acids with sulphur or sulphur monochloride.

B.P. 593,799. Application date: 3.10.44. Convention date (U.S.A.): 9.10.43. Accepted: 27.10.47.

Improvements in or relating to the Milling of Plastics. To: Bakelite Ltd.

The object of this invention is to overcome the difficulties encountered in the batch milling of plastics by employing a continuous milling process.

B.P. 593,806. Application date: 19.1.45. Convention date (U.S.A.): 31.1.44. Accepted: 27.10.47.

Improvements in the Dehydration of Fluid Materials by High Frequency Electric Fields. To: Radio Corp. of America.

B.P. 593,815. Application date: 27.4.45. Convention date (U.S.A.): 27.4.44. Accepted: 27.10.47.

Improvements in the Treatment of Materials in High Frequency Electric Fields. To: Radio Corp. of America.

B.P. 593,845. Application date: 15.6.45. Accepted: 28.10.47.

Improvements in or relating to the Manufacture of Acrylonitrile. R. T. Foster. To: Imperial Chemical Industries, Ltd.

Production of acrylonitrile by reacting HCN and acetylene in the presence of an aequeous catalyst solution containing a cuprous salt and mercury.

B.P. 593,860. Application date: 16.6.45. Accepted: 28.10.47.

Improvements in or relating to the Production of Articles Moulded from Thermoplastic Synthetic Resin Material. J. Veit and J. F. Kenure.

Moulding of articles from plasticized polyvinyl chloride sheet, subsequently removing part of the plasticizer (dibutyl phtalate or tricresyl phosphate) by treating it with a solvent for the plasticizer (white spirit, butyl alcohol, butyl acetate, petrol, etc.) which has no effect on the polyvinyl chloride.

B.P. 593,891. Application date: 19.6.45. Accepted: 28.10.47.

Improvements in Electroperforation of Sheet Material. J. W. Meaker.

Perforation of dielectric sheets by means of electric arc discharges.

B.P. 593,901. Application date: 3.1.44. Convention date (U.S.A.): 10.3.43. Accepted: 29.10.47.

Improvements in and relating to High Frequency Electrostatic Heating of Plastics, especially in connection with the Moulding thereof. H. F. MacMillin.

B.P. 593,905. Application date: 28.9.44. Accepted: 29.10.47.

Improvements in or relating to the Manufacture of Films and Foils of Cellulose Acetate. K. G. A. Cock and U. G. Shapiro. To: May and Baker, Ltd.

B.P. 593,924. Application date: 20.6.45. Convention date (U.S.A.): 22.6.44. Accepted: 29.10.47.

Process of Forming Granulated Aminoplast Resin Compositions and Products so Produced. L. Smidth.

B.P. 593,929. Application date: 20.6.45. Convention date (U.S.A.): 20.6.44. Accepted: 29.10.47.

Process for the Production of Improved Products from Hydrolysed Copolymers of Ethylene and Vinyl Esters. To: E. I. Du Pont de Nemours and Co.

Refers to Insolubilization of such copolymers by blending with benzoyl peroxide and subsequent heating to 120-200 degrees C. until insolubilized.

B.P. 593,930. Application date: 20.6.45. Convention date (U.S.A.): 20.6.44. Accepted: 29.10.47.

Process for the Production of Improved Products from Polymers of Vinyl Esters of Saturated carboxylic Acids. To: E. I. Du Pont de Nemours and Co.

Similar to B.P. 593,901.

B.P. 593,977. Application date: 21.6.45. Accepted: 30.10.47.

Improvements in and relating to the Manufacture of Dyed Artificial Resins. E. W. Jackson, B. C. Westley and J. Buckingham.

Dyeing of di-allyl phtalate resins by polymerizing the monomer to a stage where the product has sufficient strength for handling, but is not impermeable to a liquid dyestuff, treating the product with a liquid dye and continuing polymerization until complete.

B.P. 593,997. Application date: 22.6.45. Convention date (U.S.A.): 23.6.44. Accepted: 30.10.47.

Process for the Depolymerization of Tetrafluoroethylene Polymers. To: E. I. Du Pont de Nemours.

Production of monomeric tetrafluoroethylene by heating its polymer at a temperature above its decomposition point and under a pressure not exceeding 150 mm. of mercury.

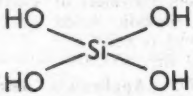
The Microscopic Examination of Plastic Materials

VI.—Mouldings—(g) Mineral Fillers (Contd.)

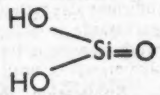
By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

IN discussing mica and asbestos we dealt with two mineral substances which may be basically regarded as silicates. These substances are complex salts based on hypothetical acids, but as they comprise a large proportion of the earth's crust, they are very abundant in nature in various forms. Therefore, it is advantageous to consider their structure which appears to be curiously akin to that of some plastic materials.

Up to recent times the structure of the silicates was purely hypothetical and was generally classed as being based on the two silicic acids possessing hypothetical structures. The so-called ortho-silicic acid H_4SiO_4, was considered to consist of four hydroxyl groups placed round a silicon radical.

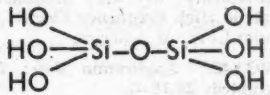


This substance was believed to be somewhat unstable and to pass into meta-silicic acid, H_2SiO_3, consisting of a silicon atom grouped with two hydroxyl radicals and a double bonded oxygen.



This change was thought to have been brought about by loss of the elements of one molecule of water. Then, by the substitution of metallic elements for the hydrogen atoms in these cases, various mineral substances are formed; for example, the mineral willemite may be considered to be the zinc salt of ortho-silicic acid, $ZnSiO_4$, and enstatite, the magnesium salt of meta-silicic acid, $MgSiO_3$.

It will be seen that the existence of the double-bonded oxygen atom in the meta-silicic acid leads to an unstable molecule and therefore condensation is possible between two molecules of ortho-silicic acid, resulting in the production of one molecule of the so-called ortho-di-silicic acid $H_6Si_2O_7$.



It is therefore conceivable that in this way the whole range of ortho-di-silicates may have originated, e.g., the mineral serpentine $Mg_3Si_2O_7$. In this way also may a range of meta-di-silicates be obtained, leading to further complexes of tri-silicates and even poly-silicates.

The development of this hypothesis was necessary originally, due to inherent difficulties of investigation by ordinary chemical methods, and it was only in comparatively recent times that the structure of these substances has been made clear, due mainly to the work of Bragg and his contemporaries, using methods of X-ray analysis, from which it was shown that the chief differences between the various silicates were due to the manner in which the silicon-oxygen grouping was arranged, this structure generally extending throughout the crystal in an endless network and only occasionally forming a closed group, reminiscent of the ordinary acid radical.

The X-ray analysis showed that the

silicon atom is always present in association with four oxygen atoms, which are disposed around it in tetrahedral arrangement; this structure is well known, as in the case of the diamond, to result in stability. It would appear that the relationship existing between these tetrahedral groups and their pattern in the structure of the substance, is the controlling factor influencing the structure of the particular silicate in which it exists.

Thus in a simple ortho-silicate, such as olivine $(MgFe)_2SiO_4$, the tetrahedrons exist as separate groups and behave in the same manner as a quadrivalent acid radical. The oxygen atoms at the corners of the tetrahedron carry a negative charge, being attached to the central silicon atom by a single bond in each case. It is these external "negative" charges which constitute the holding forces, and so keep the metallic ions in position in the structure.

This arrangement is found in the simplest cases. In the more complex structures, however, it appears to be possible for a linking-up of the tetrahedra, one with another, to take place, by means of which two of these groups share one oxygen atom. Thus it will be seen that if two tetrahedral groups are linked together by a single corner of each group, then the sesquivalent (Si_2O_7) group results, which, as we have seen, is the foundation of the ortho-di-silicates.

Further linking-up in different arrangements seems to be possible. It has been shown that three tetrahedra may link up through three oxygen atoms to form a three-membered ring (via the oxygen bridges), again producing a valency of six. Further groups have been observed to exist, forming four- and six-membered ring structures, whilst the tetrahedra may also link up to form chains of indefinite length by a corner-to-corner arrangement. Thus, in a crystal of such an arrangement the chains extend right across the crystal in a series of bands, which are held together down its length by the metallic ions between them. In other cases the transverse structure consists of two chains linked together by sharing other oxygen atoms to comprise a chain of six-membered rings, which, in turn, are linked by the metallic ions to form a long crystal. In this way the fibrous minerals are built up, and it will be appreciated that the linkage of the tetrahedra is continuous throughout any one crystal, which, in reality, may be considered as a giant molecule.

In view of the formation of long chains, it is not unreasonable to expect the further extension of this linking of the tetrahedra in a second dimension, through three corners of each group. This does occur and results in the formation of sheets, the usual arrangement having an indefinite extension of linked six-membered rings. In this case three oxygen atoms in each of the tetrahedra are shared, thus leaving only one free oxygen atom for linking with metallic ions. In this way minerals such as mica and talc are formed, which are characterized by their fine lamella structure, each sheet of which in the ultimate is presumably the thickness of one layer of tetrahedra.

Thus we see that the silicates in general form crystals which are very similar to certain plastic materials in that they may be regarded as possessing a continuously linked structure resulting from the condensation of the hypothetical ortho and meta silicic acids. As with plastics, the degree of linkage influences the physical and chemical properties, and it will be noticed that as more of the oxygen atoms become shared, so does the percentage of metallic ions decrease, resulting in a more stable substance, as evidenced by the greater physical stability of mica when compared to that of asbestos; greater chemical inertness also results.

In the same way as the extension of linking in two dimensions was expected, so may the possibility of linking in three dimensions also be anticipated, and when this occurs it is clear that all four corners of the tetrahedra are linked with other similar points. This leaves no vacant valency for the holding of metallic ions, with the result that we have a material

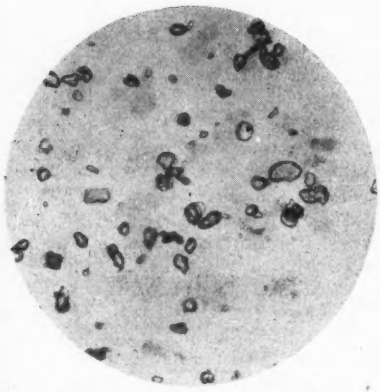


Fig. 254.—Fuller's earth. Mag. 100 diameters.

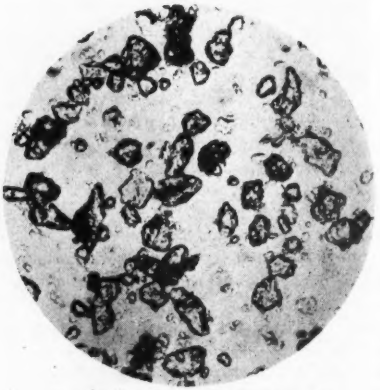


Fig. 255.—Fuller's earth. Mag. 200 diameters.

linked in three dimensions, consisting of silicon and oxygen only. This is silica itself, in one of its forms, such as quartz, whose stability and inertness need no emphasis.

In general, the reason for the surface inertia in this type of mineral becomes apparent, resulting in the fact that there is no intimate bond between resin and filler. When considering fillers it must be remembered that such adhesion as exists does so by virtue of the intimate surface contact between the two components. This contact can only be achieved when the surface is properly wetted with the resin, this latter condition being obtained by reducing the surface tension of the resin with alcohol or some miscible substance of a like nature; however, as in the powder ready for moulding, the alcohol is not present; the high surface tension of the resin will come into operation in the press and negative some of the beneficial effects initially obtained by the use of alcohol, although it is highly probable that some considerable benefit may be obtained by pretreatment of the filler with an alcoholic solution of the resin. This factor must be recognized as being very real if disappointment is to be avoided.

The question of the bond between the resin and the filler particle, as we have seen, is of paramount importance when endeavouring to obtain the maximum possible strength with any given material and the general weakness of the bond is, apparently, mainly responsible for the lack of strength in tension to be found with mineral fillers. This would seem to be greater in the case of those materials of a granular nature such as the frangible clay known as "fuller's earth." This is a silicate clay which is not infrequently used as a filler in order to impart to the finished moulding characteristics, such as hardness, a certain amount of heat resistance and chemical inertness.

Fuller's earth is granular, as can be seen from Fig. 254, illustrating a sample at 100 diameters. It will be noticed that like all materials of this type the general morphology of the particles does not tend to be confined to any particular shape, but may vary from a roughly rectangular outline to almost spherical, from which one could conclude that adhesion of the resin could be more easily broken down than would be the case with a lamella particle such as encountered in a mica filler. The reason for this lies in the greater area of adherent surfaces in one plane, to be found with mica, thus assuming the particles of mica to be lying so that they

are all flat. A tensile stress applied in the horizontal plane would then result in a shear stress at the resin-mica interface, and as almost the entire area of the mica particle will be so stressed, it must exhibit a greater effective strength than that shown by the fuller's earth particle; the latter, being of a granular nature, has a considerable portion of its total surface area subjected to a tensile stress tending to pull the adherent surfaces apart.

The problem, however, does not appear to be as simple as this, because, if one considers the well-known case of Johannson gauges, these blocks are easily separated by a shear stress at the interface, but are difficult to separate by the application of a tensile stress at right angles to the interface, such as would be present in an endeavour to pull them apart.

However, in the case of the moulding the conditions are somewhat different, as the interface occurs in the structure of the material where the strength of the surrounding medium (in resin) is considerable in comparison with that in the case of the gauges, where the surrounding medium is air. In actual practice it is found that there is little, if any, difference in the strengths of these two types of mineral filler, their tensile strength lying between 4,000 and 1,000 p.s.i., but here again we encounter the old question of a wide range and in the absence of data detailing the strengths obtained by specific filling materials, no definite statement can be made.

Apart from these considerations, it will be seen that the particles in these mineral flours are very variable and the fuller's earth sample shows a fair proportion of fine dust-like material. The existence of even finer particles is shown at higher magnifications; these are easily distinguishable in Fig. 255, showing some of this material at 200 diameters. This illustration clearly shows the great range of particle size to be encountered, and, in view of what has already been demonstrated with regard to the effects of a high variability index, it would appear probable that an improvement may be effected by more careful sieving methods applied to mineral flours, for there is no reason to believe that benefit cannot accrue as a result of this.

So far the only filler composed of silica, as such, which has been dealt with, was the silica flour described in the last article (see "Plastics," January, 1948), there seen to be composed of granular material, possessing a high variability index. The material itself is almost pure silica and as such is a very good filler for conferring heat-resisting properties to the finished moulding.

It is now proposed to discuss, briefly, another silicious filler in the form of diatomaceous earth, but before doing so, it will be advantageous to know something about silica in general. We have seen that silica is a three-dimensionally cross-linked arrangement of the silicon-oxygen tetrahedron, and it is due to this arrangement that the material possesses its great stability and inertness. The chemical formula for the material is SiO_2; in this form it occurs in nature in great abundance, both in combination, as in silicates, and in the free condition. When it occurs in the free state it may either be crystalline or amorphous and does so in three general types; these are known as quartz, tridymite and crystabalite.

Quartz is too well known to need emphasis; let it suffice to mention that it occurs as hexagonal prisms which are capable of developing to very great sizes. When pure quartz is colourless, traces of metallic oxides are sufficient to produce various colours; thus manganese is responsible for the production of amethyst quartz and carbonaceous matter produces what is known as smoky quartz, while in the case of the so-called milk quartz, the effect is due to the presence of very large numbers of air bubbles.

The occurrence of amorphous silica in nature is thought to be due chiefly to the presence of some 12 per cent. of moisture as in opal, while other substances such as flint and chalcedony, etc., are usually amorphous silica in association with

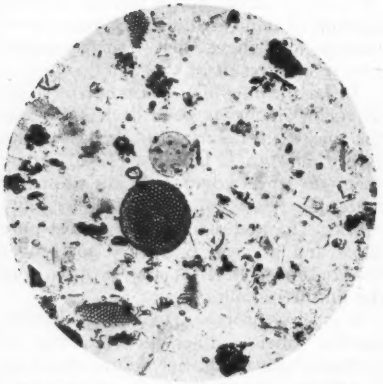


Fig. 256.—Diatomaceous earth. Mag. 100 diameters.

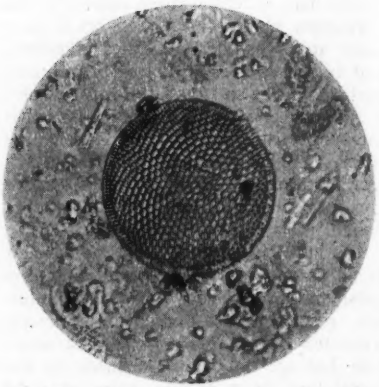


Fig. 257.—Diatomaceous earth. Mag. 250 diameters.

quartz; thus the diatomaceous silica is usually opaline, but that of some of the older deposits show signs of crystallizing into quartz, which appears to suggest that quartz was originally opaline silica.

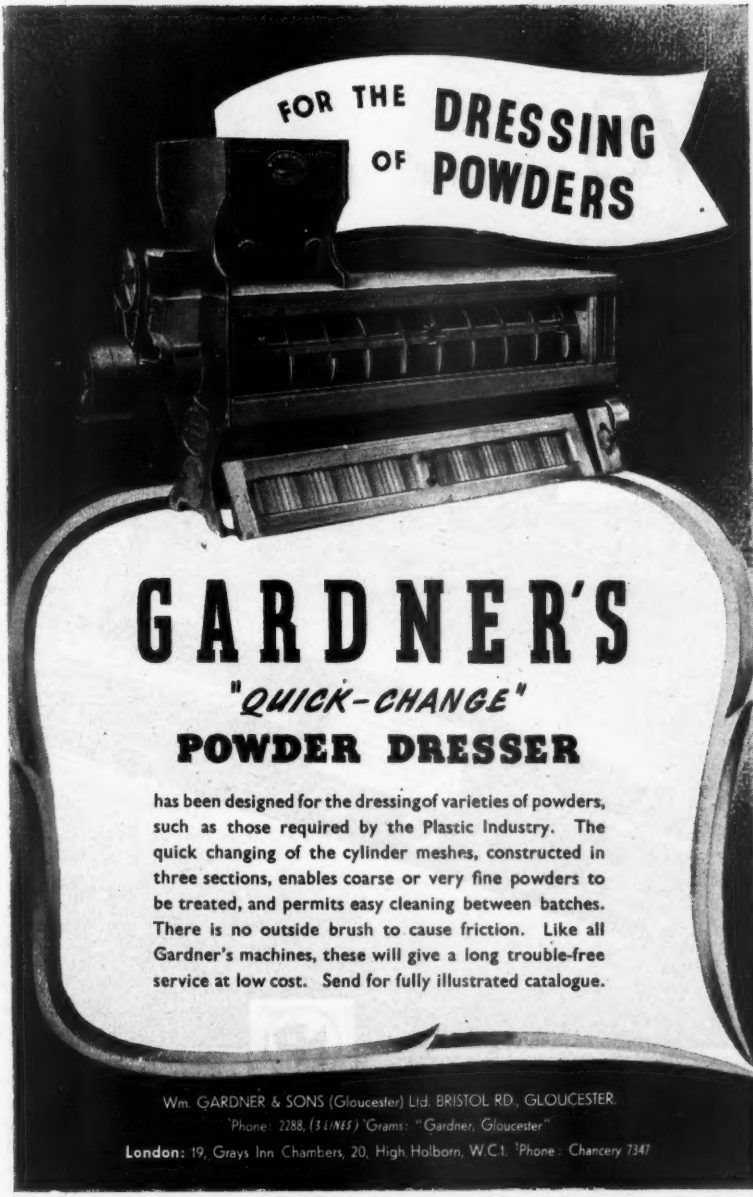
Diatomaceous earths are, when pure, composed of diatomaceous silica. The earth may be considered as being very fine in texture, each particle being the external skeleton of a marine planktonic organism. These are found in the form of earthy deposits which were laid down in distant geological times and from this they may be considered as being fossilized. The older the deposit the more likely that the silica is in the crystalline condition.

The diatoms themselves are simple cells which possess an external coating or skeleton mass of silica, within which is the living cell. The silica coating is secreted and consolidated by the anabolic functions of the cell, but the actual method by which this is accomplished is not at present clear. However, the presence of the silica is one of the most distinctive characteristics of the group of diatomacæ, being considered responsible for the surface markings of its members which will be discussed subsequently.

It has not yet been established beyond doubt that diatoms are animals, and in view of the presence of a cellulose wall covering the cell, the possibility of these organisms being plants cannot be overlooked, however much the same problem exists with regard to bacteria, and in the absence of conclusive evidence to the contrary, one is forced to regard them as being on the border line between the animal and vegetable kingdoms, in other words, as being a transition form.

The development of the silica coating was at one time thought to be originated as a separate layer on the cellulose wall, but it would appear to be more likely that the silica is laid down and interpenetrates the cellulose wall itself. If this be true, then we have in the diatom an organism which is capable of developing silica in the same way as an ordinary plant develops lignin, hence the mature diatom may be considered to be silicified instead of lignified.

It seems reasonable to suppose that the development of silica in this fashion would be more liable to result in the production of amorphous silica than would be the case if it were deposited as a separate external coating, which latter might very well be expected to be crystalline, and as the crystalline condition supervenes only after long fossilization, it is highly probable that the silica is originally laid down in the same basic manner as lignin.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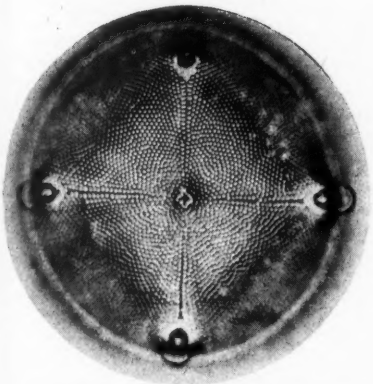


Fig. 258.—Diatomaceous earth (Arachnoidiscus). Mag. 160 diameters.

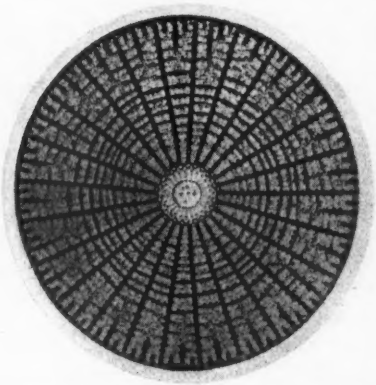


Fig. 260.—Diatomaceous earth (Arachnoidiscus Japonicus). Mag. 160 diameters.

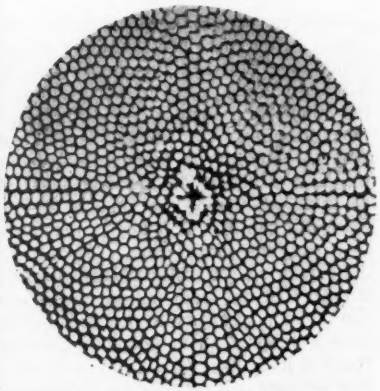


Fig. 259.—Diatomaceous earth (Arachnoidiscus). Mag. 510 diameters.

The living cell itself does not require a great deal of discussion, apart from saying that it is structurally typical of such organisms in general and shows distinct characteristics of a plant cell; for example the development of silica and the presence of a modified form of chlorophyl.

As the silicious skeleton, however, is the portion of immediate interest, it is expedient to discuss this in some detail. As we have seen, this material in all probability is laid down in much the same manner as lignin; we are, therefore, justified in expecting this to be developed in patterned forms similar to those found in the plant cell walls. Whether the assumption of the method of development of silica is correct or not, it is an indisputable fact that the silica is intricately and very often beautifully patterned. The structure of this silicious casing is curious and its investigation has led to much controversy regarding its details. The literature relating to diatom structure and classification is vast, but as yet the actual details of diatom structure have not been fully elucidated.

The casing itself would appear to consist of two symetrical valves which fit together as do the two halves of a box. The surface is covered with minute markings arranged in complicated geometrical patterns. An idea of the complexity of these patterns may be obtained from Fig. 256, which shows a sample of diatomaceous earth at a magnification of 100 diameters. The illustration clearly shows the powder to be made up of large numbers of these skeletons, or shells, and pieces thereof. In the majority of instances the marking is clearly seen, particularly so in the case of the large circular diatom in the centre, which exhibits a very regular series of marks giving the appearance of a number of minute perforations. All diatoms are not neces-

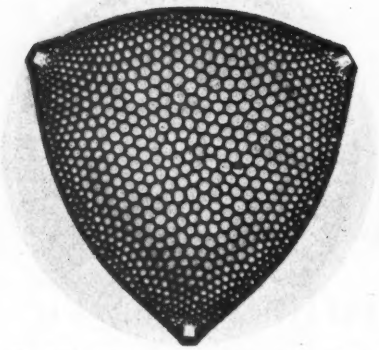


Fig. 261.—Diatomaceous Earth (Triceratium grande). Mag. 100 diameters.

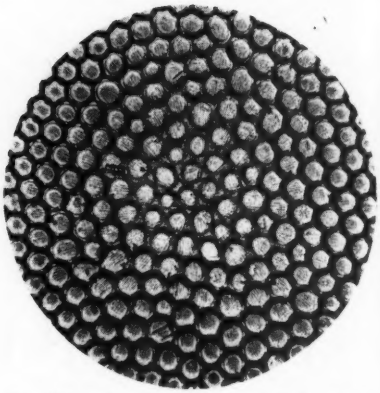


Fig. 263.—Diatomaceous Earth (Triceratium grande, lower surface). Mag. 200 diameters.

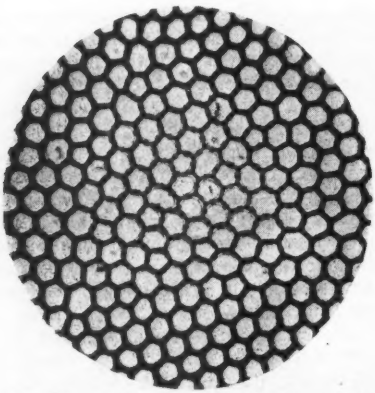


Fig. 262.—Diatomaceous Earth (Triceratium grande, upper surface). Mag. 200 diameters.

sarily shaped in the form of a circular box. This general morphology takes on a number of forms. Thus the box when complete may be in the shape of a sphere, or it may be lenticular, triangular, heart-shaped, boat-shaped, etc., but in spite of this variation in shape their surfaces are always marked in regular patterns.

The nature of the diatom's marking has been, and still is, the subject of one of the most interesting investigations carried out on a world-wide scale, and in the present state of knowledge it is not possible to say what they are or how they occur. Thus there is a school of thought which puts forward the theory that the markings are a series of perforations in the alternate structure, but others say that this is not so, as nobody has yet been able to demonstrate having resolved the ultimate structure of the markings. If we look at one of the smaller diatoms from our samples at a higher magnification, as shown in Fig. 257 at 250 diameters, we see distinct signs of a finer structure in the main pattern visible and sub-division of structure proceeds to very minute limits. The problem therefore resolves itself into endeavouring to ascertain whether it is possible for these superimposed structures to exist, if they were composed of a series of perforations, or whether the perforations are not, in reality, a series of holes at all, but instead a number of lenticular prominences or depressions in the surface of the silica, for it will be seen that if this is so, then the structure could quite easily be mistaken for a series of perforations.

The manner in which the shape and patterning of diatoms may vary is shown in Figs. 258 to 265. The magnification in each case is stated and thus we see a circular type (Arachnoidiscus) of relatively coarse structure in Figs. 258 and 259, the latter illustration showing the

Fig. 264.—Diatomaceous earth (Plurosigmæ, a typical elongated diatom). Mag. 100 diameters.

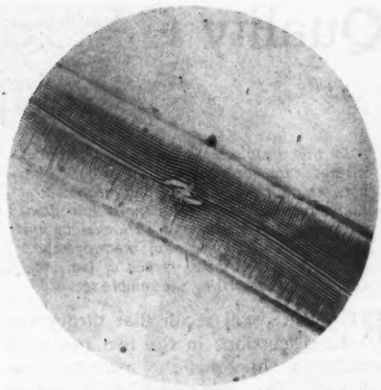


Fig. 265.—Diatomaceous earth (Plurosigmæ, showing fine slotted structure). Mag. 510 diameters.

central structure at a higher magnification. In Fig. 260 we see another discoid type, with an entirely different method of working to that previously shown.

An interesting type of triangular diatom, Triceratium grande, is shown in Figs. 261 to 263. The first illustration serves to show the general shape of the valve and the coarse structure, but suspicions of a finer structure are confirmed by an examination of the top surface at higher magnification (Fig. 262). Above the more central cells of the honeycomb-like structure are seen portions of rows of minute dots and on examining the lower surface (Fig. 263) these dots are seen to cover the entire surface of the coarse structure, apparently as a continuous film or membrane, capping the cells. Yet another shape is seen in the greatly elongated diatom shown in Fig. 264; those are typed as Plurosigmæ, and in general show a very fine slotted structure of great regularity of the type shown in Fig. 265, which is the same diatom at higher magnification.

In general it will be seen that in the case of diatomaceous earth there is a fairly wide variability index, although this would not appear to be so great as in the other powdered mineral materials. The resistance produced is good and the finish is very good, but owing to the nature of the material it is highly abrasive and in consequence is the cause of much wearing of moulds; as a result of this, diatomaceous earth is more usually employed in conjunction with other filling materials of a softer nature.

With this very brief discussion of the mineral fillers, we conclude the section in filling materials in general and will continue with the examination of mouldings in the hope that the use of the microscope for this purpose will produce information which might be of some value to both manufacturer and user.

(To be continued.)

An Alternative to Steel Gas Pipe

Extruded "Tenite" plastic tubing is said to be replacing steel gas pipe for domestic installations in America. According to Tennessee Eastman Corporation, the 1-inch Tenite (cellulose acetate-butyrate) tubing has several advantages over steel. It is readily available compared with steel pipe, the latter being in short supply. It is also lighter in weight than steel and therefore shipping costs are lower; at the same time it is more easily handled. It can be bent on the job and requires but little equipment for making the joints. Deterioration in contact with most soils is resisted. The installed cost is lower than that for steel.

Quality Control in Plastic Moulding—III

By W. M. HALLIDAY

In this instalment the author describes methods for determining the relationship between natural tolerances, and mean control limits, and the dimensional limits laid down by the component drawing. He explains the derivation and advantages of the range chart which covers variation spread of individual components comprising the sample set.

READERS will recall that throughout the discussions in the two preceding articles a hypothetical example was selected. This consisted of a simple compression-moulded sleeve produced from an equally simple tool. By choosing such a simple component it was easier to illustrate the steps and general procedure to be adopted for the institution of quality control methods over its production.

These methods and procedure will, of course, be substantially the same for every kind of moulded component selected for control in this manner. One important point should be emphasized, however. It will be remembered that in respect of this example *only one* dimension was to be controlled, and that only within the natural limits of dimensional variation possible with the kind of moulding tool available.

In actual practice, such a set of simple conditions is rarely encountered. In the first place, most moulded articles have to hold to certain tolerances of size variation upon *several* dimensions instead of a single one. Secondly, if the article is of the precision-moulded component kind the important dimensions will have to be maintained to limits laid down by the drawing supplied by the client who is to purchase the finished products. Usually such drawing limits imposed on a job are finer, or stricter, than the natural ones which the mould can produce without any scrap. Thus, precision mouldings are now regularly produced where the moulder is able to control and guarantee dimensional variations within the small limits of plus or minus .002.

When considering the introduction of quality control for such mouldings the vital question arises as to the relationship between the natural tolerances and those of a closer character laid down by the drawing. The importance of the correct solution of this question will be realized from the following reasons:—

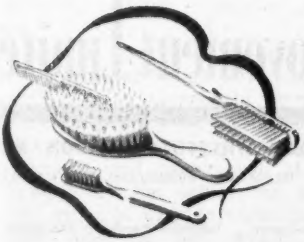
(1) Unless the production engineer or moulding inspector knows beforehand what this relationship is exactly, he is not in a position to determine whether or not the mould is capable of meeting those requirements.

(2) The same difficulty arises of assessing the feasibility of the press set-up and the moulding procedure.

(3) Considerable scrap and wasted effort may ensue if production is embarked upon without first determining this relationship. Where it is not reliably known before production is commenced, or gets fully under way, a certain period of running the mould will have to be effected. During such a try-out period large quantities of faulty, defective or even entirely scrap components may be produced. These may represent a dead loss if they fall short of the requisite degree of accuracy stipulated by the drawing.

(4) A great deal of time may also be wasted in the manner following. Should such cut-and-try methods reveal that the mould or methods of operating it are incapable of producing a sufficiently economical percentage of accurate mouldings, considerable investigation and adaptation may be conducted.

Plastics go to her head



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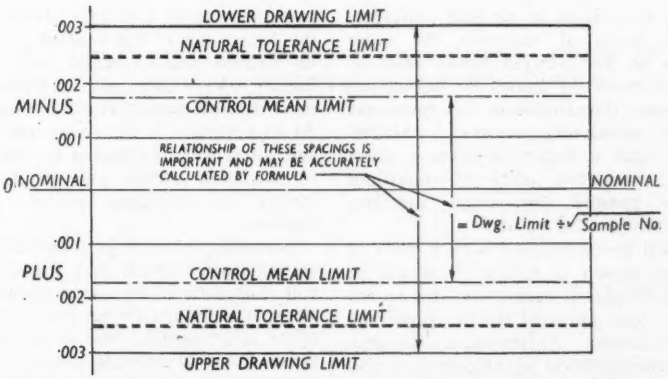


Fig. 1.—Application and relationship of drawing limits to a control chart.

Thus, the mould or moulding procedure may be appreciably modified in some way; or a new mould may have to be made and tried out in a similar manner. In actual practice this adaptation of a mould to obtain accurate mouldings, or an economical rate of production, often absorbs a considerable amount of time, attention and expense. Hence the great utility of being able to resolve one of the problems—that of the degree of accuracy of the products at the outset.

Relationship of Drawing Tolerances to Control Chart

Returning now to the second question, viz., the relationship between the natural and control mean tolerances and those denoted on the component drawing, an important point is contained therein which it is desirable to settle before proceeding to the next stage on the construction and use of quality control charts.

As will be appreciated, it is essential that the drawing limits governing the dimensions of a component be represented upon the control chart by means of datums. Fig. 1 shows the usual arrangement, and readers will at once understand that the datum lines of the control mean of average variation over samples must lie well within those denoting the drawing tolerances. If they do not it will immediately be clear to the production moulder that a certain proportion of the output will be faulty and rejected on account of non-compliance with the drawing tolerances.

Should a chart be constructed having the datums of the drawing limits located *inside* or only just outside those of the natural limits, it will be impossible to control the production with the degree of assurance and exactitude required, as will be illustrated later.

Referring again to Fig. 1, it will be observed that this chart is, in effect, divided up into five zones, the inner one, bounded by the two control mean limits, being a much wider zone than the others. At each side of this central zone there is a narrower one bounded by the datums of the natural limits, and finally the extreme outer ones bounded by the drawing-limit datums.

If, when compiling the chart during a production run, plotted points consistently occur in the central zone, all is well. If they occur in the adjacent zones, however, production is shown tending towards error, and examination should be made. Plotted points in the outer zones mean that scrapped parts have already been produced.

Naturally, in the case of the manufacture of precision mouldings having

certain dimensions to be held uniformly to fine limits of variation, the outer datums of the drawing limits must be situated closer to those of the natural tolerances; therefore this will mean the range of permissible variation is reduced. Where such a factor involves a chart having these two pairs of important datums located too close together, modifications must be made.

As will be understood with a chart of the kind shown at A (Fig. 2), it will be difficult to plot it accurately, due to the narrow zone afforded by the proximity of the datums. Furthermore, the pictorial representation of the control is also largely neutralized, making it difficult for an observer to gain a true understanding of the production tendencies. To overcome such disadvantages, it will be necessary to modify the chart, bringing it to a much larger scale, in the manner shown at B (Fig. 2). Here, as will be seen, the respective zones are much larger and plottings on the chart are easier to locate properly.

On this latter-mentioned chart it will be noticed that plotted points tend to approach the natural-limit datums; in a few instances they actually pass beyond. To correct such a tendency, two courses will be open to the moulder or inspector.

First, he should at once stop production in order to conduct a thorough check-up of the entire sequence of activities. This would first of all embrace a testing of the moulding tools to determine its accuracy, proper working, and so forth. Next, the press set-up should be similarly checked for adherence to original mounting or the presence of some disturbing factor not present initially. The action of the operator and his methods of working the mould, etc., would be checked over, again to ensure that no serious unauthorized departures from the proper cycle of movements had taken place.

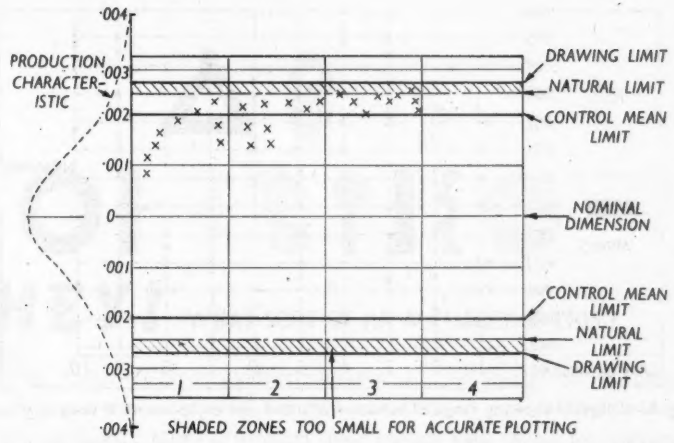
Incidentally, it is worth while mentioning here in passing that very often this latter factor is the cause of numerous variations in moulding operation. It sometimes leads to drastic deviations in the dimensions of the finished product or its surface finish, weight and general quality. Very often, also, it is one of the most difficult causes of trouble to locate. At a later point in this series special consideration will be devoted to this aspect of moulding practice and the ways and means of effecting proper control thereon.

Secondly, should it be found after such an exhaustive check that the output is still characterized by unacceptable variations, it will then be necessary either to effect some modification of the drawing limits so as to provide greater working tolerances on the job, or, failing that, to undertake a re-tooling of the complete operation.

It will have been made clear that the mould, or press, or both, in their present state are incapable of ensuring uniform production to the limits required. Provided the mould has been correctly and intelligently designed and constructed, this latter remedy would not arise, the troubles usually being overcome by correction, adjustment or minor alteration of the mould by the maintenance toolmaker.

It is worth emphasizing, however, that the introduction of quality control methods of inspection on precision mouldings immediately reveals whether or not the mould and set-up generally is capable of producing parts to such fine limits. This is a very important point for the mould designer and production engineer, since both of them will learn conclusively at a very early stage in a production run whether or not the tool is up to the standard of accuracy required. Production of precision mouldings on a consistently economical basis can, indeed, be obtained only in this way. Other methods involving the extended production of large numbers of parts comprise too great a degree of guess-work to be reliable or even justifiable.

The control mean datums, we have seen, must lie some appreciable distance *inside* those of the natural tolerances. They should also be located a similarly



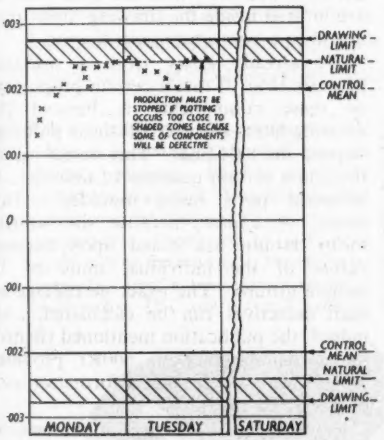


Fig. 2.—Charts A (above) and B (left) illustrating the importance of a correct proportioning of control zones.

substantial distance within the drawing limit datums.

Now, the extent of this latter distance can be exactly determined for any particular job once the preliminary decision of the size of a sample group has been made. The relationship between the control mean limits and the drawing limits is expressed by the following proportion: "The distance between the control mean datums must not be greater than the distance between the drawing tolerances divided by the square root of the sample group size." Thus, with a sample group of, say, 10 individual mouldings, the distance between the control mean lines of the chart would be approximately one-third of the distance between the drawing limit datums.

This is an extremely important factor, and for those wishing to go further into the study of the statistical derivation of this proportion, reference should be made to Publication 600R of the British Standards Association which deals extensively with this question and the relationships between various sample group sizes, and drawing limits have been worked out and tabulated. Thus, the respective distances can be readily obtained by referring to a simple table.

Before proceeding to the next point, a simple example will perhaps make this relationship clearer. Fig. 3 shows the variations of the measurements from over 10 sample groups taken consecutively from a plastic moulding production run. Each sample group consists of 10 individual mouldings, each of which is measured only on one dimension for the sake of simplicity. This gives in all 100 measurements, which are plotted out on their respective vertical lines in the chart.

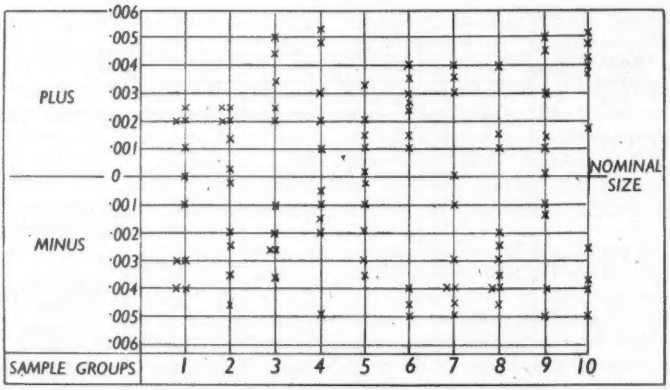


Fig. 3.—Diagram showing range of variation of individual components in sample groups.

The left-hand vertical ordinate is measured off in variations plus or minus the nominal size. These rise or fall in increments of .001 in. Special attention is called to the amount or range of-variation of these plotted points. As will be observed, the bulk of the plotted points are situated within the plus or minus .003 lines. Quite a few are beyond these lines up to the .004 marks, and some are *located around* the plus or minus *.005 lines.*

At Fig. 4 these same points are shown after they have been averaged out to obtain the sample mean, in the manner previously explained. The control mean lines are provided on this chart. They are calculated in reference to the drawing limits, which latter in this instance are plus or minus .004 in. The relationship of the control means, then, to these latter limits is found by the following calculation: $1\sqrt{10} \times .008$, which equals .0025. This spacing of the control mean datums is, of course, made to the same scale for the rest of the chart.

Now, it should be noted that in this instance, where we have a drawing tolerance of plus or minus .004 and a control mean of plus or minus .0025, the sample mean is actually .003. With such a chart as this, the production moulder might imagine that the output is being effectively controlled. Actually this is not the case, because whilst the control limits are located inside the drawing limits they are so to a *very inadequate degree.*

We already know from a previous diagram (Fig. 3) that a certain proportion of these components is beyond the drawing limits—in fact, all those plottings beyond the .004 lines. This would result, then, in a certain quantity of defective or scrapped parts being moulded. This arises, of course, because the control mean datums are based upon average values of the individual units of 10 sample groups. The exact percentage of such defectives can be calculated, and, indeed, the publication mentioned (British Standards Association, 600R) provides tables from which such information can be extracted easily.

Referring again to Fig. 3, it will be seen that no less than 16 points lie outside the drawing limits and represent scrap components. So that in this particular instance with a chart based on these results, as depicted at Fig. 4, the percentage of liable defectives would be 16.

It is hoped that it will now be clear that even though the datums representing the control means lie well inside those of the drawing tolerances, the *full* tolerance applicable to the job is being utilized. Yet there must be some margin, otherwise the occurrence of a plotted point beyond one of the control mean lines, but

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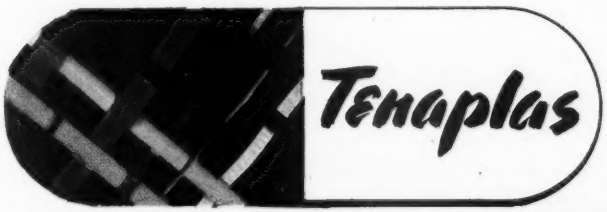

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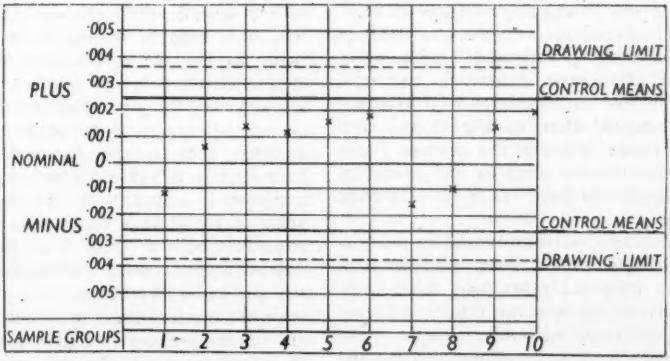

Fig. 4.—Chart of the "sample mean" derived from variations of measurements shown in Fig. 3.

within the drawing tolerance ones, will not only indicate that there is a tendency towards producing defectives; it will, in fact, mean that some percentage of scrap has already been produced.

The solution to this difficulty can be obtained in two ways. In the first place, the accuracy of the individual components could be improved, so that plottings on a similar diagram to that given at Fig. 3 would not occur beyond the drawing limits of plus or minus .004. This reduction in the range of variation would in turn produce a lower mean figure on which the control mean datums are based. These would then be relatively closer together on the chart, as shown at Fig. 4.

On the other hand, the control mean datums could be moved closer together, bringing their location to .001 less than the sample mean variation of the 100 individual components tested. This would bring it down to a zone bounded by control lines at plus or minus .002.

This is an alternative method of calculating control mean positions in those cases where leakages of the kind being discussed are liable to occur. Readers will find this alternative calculation discussed in the above-mentioned publication of the British Standards Association. It is a most important point, of course, and not simply a theoretical statistical nicety, since it will be obvious that the accuracy and reliability of the production control is based upon the maintenance of a correct proportion between the datums on the control chart.

Naturally, in the space available it has been possible to deal only very sketchily with this important subject, but it is hoped that enough has been said to indicate to readers that it is vitally essential to have the control mean datums positioned amply within those of the drawing limits. Failure in this respect has often led to the establishment of inadequate control over quality and accuracy, with the resultant passing of faulty components to the client. Such occurrences have brought discredit on the entire system of quality control, and a consequent tardiness towards its acceptance and development. Where, of course, it is impossible to obtain the correct relationship between control mean limits and the required drawing limits, and always providing that the mould and set up have been proved as accurate as possible, the solution will, of course, be the increase of the drawing tolerances.

Producing a More Uniformly Accurate Product

There is a converse side of the picture. Sometimes it is found that a mould is capable of producing components to closer limits of accuracy than prescribed by the drawing. Two alternatives are

open to the production moulder to meet such circumstances. On the one hand, he can continue production, employing a control chart with datums in the relationship just described, or he can use a fresh adapted chart having datums with the distance between the control limits much less than is given by the previously mentioned formula, 1 N × Drawing Tolerance.

This latter provision would ensure that any plotted points lying outside such datums may not mean that these components would be scrap. Such different and special control limits, however, need not concern us at the moment, since the bulk of precision plastic mouldings are usually associated with quite strict tolerances, covering dimensional variations.

One final point before passing along to the next subject involved in the construction of effective control charts. It is to note the great assistance capable of being rendered by the control chart thus correctly related in *preventing* the moulding of faulty parts. The production engineer and inspector is able to discern the trend of plotted points towards one or other of the vital control lines and to take appropriate action from such pictorial warning.

Sometimes, however, there are no such warning tendencies exhibited on the control chart. A plotted point just unaccountably falls outside one of the essential controls, indicating that defective parts have been made. There is then only one course of action to take. That is, to submit the quantity of components represented by this part to a full 100 per cent. check in order to locate the few scrapped parts we know will be there.

Having effected such a comprehensive inspection test of the suspected batch, all possible steps should, of course, be taken to ensure that the next plotted point coming on the chart, coinciding with renewed production, shall be located within its proper zone.

It will now be quite clear from our discussion upon the intimate and important relationship borne between the control and drawing specifications limits that it is entirely wrong to assume, as many do, that the introduction of quality control charts entail the cutting-down of tolerances of the job. The author is well aware that many production engineers harbour such a misconceived notion, because of which they are unduly cautious and slow in accepting the principles and utility of the system, which is an essential requisite before one can fairly or ungrudgingly agree to its introduction on any particular operation.

On the contrary, it is only fair to point out that the use and intelligent application of quality control charting procedures along the lines already discussed enables the moulding engineer in particular to derive very comprehensive knowledge of the production activity, which he cannot obtain in any other way.

Possession of such knowledge, in its turn, imparts such a degree of confidence that he often is empowered to work far closer to the imposed limits given on the component drawing than he would otherwise have been able to do. This, in fact, is one of the chief advantages to be secured from an introduction of the system, and much more will be described in later sections to illustrate the numerous ways in which plastic moulding operations have become simplified thereby.

Components with Several Features to be Controlled

With most plastic mouldings usually a number of different dimensions, or features, have to be maintained within specific limits of variation. It is therefore now necessary briefly to describe the slightly modified procedure to be adopted for constructing and using quality control charts to cover their production. This procedure is really quite straightforward, and readers who have carefully followed the preceding discussions on the formation of control charts for the simple example so far considered, having only one dimension to be controlled, will have more than an inkling of the course to follow.

In the first instance, when taking samples from the production run, preparatory to making the control chart, each individual component would be checked or inspected at all the essential points. These results would then be tabulated so as to show the range of variation of each item in respect of every dimension, etc. Average values would then be calculated in order to ascertain the "sample means," in similar manner to that described last month ("Plastics," January, 1948, pp. 48-49).

One important point arises at this stage, however. When a number of features have to be controlled a larger number of sample groups should be selected in order to allow fullest scope for all possible variations of each dimension or feature. Obviously, if only a small number of sample sets are checked, a reliable picture of the production conditions cannot be obtained, since certain dimensions, etc., may remain stable and uniform for short periods and then suddenly show variations.

From the range of variation depicted in the tabulated results of the checkings made, the production engineer can gain a good idea of whether a sufficiently large number of sample groups have been taken. He would continue to take sample sets until each dimension being measured became more or less steady in respect of any variations from limits prescribed for the job.

Likewise with respect to the number of individual mouldings comprising each sample group. Again it will be advisable to increase the number of items proportional to the increase in the number of dimensions or points to be controlled.

Thus, with a moulded article having only one point to be controlled, sample groups of three to five components will be quite reliable. Where two dimensions have to be dealt with, six to eight components should be selected from each sample group. Three to five dimensions or features to be controlled would require sample sets consisting of eight to 10 individual parts.

From the "sample mean" thus derived it will be easily possible to establish the position of the control mean datums on the chart in relation to each other and to the natural tolerance datums previously obtained for the job. Once the control chart has thus been formulated and constructed the plotting of the requisite points will follow the usual practice mentioned previously.

The visiting inspector charged with checking the production and compiling the control chart would check a number of components on every dimension or other feature being controlled and would record the results of these checkings to the control chart. Plottings would be made thereon and the production would be considered to be in control, providing all such plotted points were located in the appropriate zone between the control mean datums. The number of components to be checked by the inspector at each visit to the press or injection machine also requires some careful consideration in order to obtain a truly representative basis of the working conditions.

With a component having only one feature to be checked and controlled, the inspector would probably only measure or gauge one sample at each visit, taking care, of course, that it was one of the most recently produced articles. Where a number of dimensions are concerned it may be advisable for the inspector to inspect and gauge three or four individual components at each visit.

Incidentally, where this obtains, two methods of plotting are available. With the first method the inspector would gauge, say, four samples each visit, and he would plot *four points* on the control chart, one corresponding with each of the four results measured. The second method comprises the selection of the average value of the four measurements, and simply plotting this ascertained point on the control chart. If one of the components measured up outside the limits laid down by the drawing, the inspector would not ascertain and plot such an average point, but rather stop production

and endeavour to find out the reason for the deviation. The average value of a number of component measurings can only be used and plotted on the chart *when each measurement* is *within* the *control mean limits of the chart.*

It should be specially noted that the control mean limits are stated, and not the drawing limits. The reason is, that if the drawing limits were employed, two of the components might be extremely close to the upper or lower limit of the drawing, but the plotted point based on the average would give a completely incorrect picture on the chart. Therefore the control mean limits within the drawing limits should be employed, as this then allows a certain degree of variation on individual components which can be safely averaged out.

Charting on the Range of Variation

As was explained earlier in respect of the taking of sample means, a certain amount of data was lost. This information relates to the "*spread*" of the individual variation of a set of samples. This is important, because the range or scale of such variations is an index of the degree of uniformity of the produced moulding.

The difference between the highest and lowest variation item in the sample set affords a good indication of the accuracy of the productive process, and adherence of the components to the limits set on the operation. If effective control is to be maintained it is essential that proper track be kept of this information. One of the chief objectives underlying quality control is to uncover production trends away from or towards the required figure of accuracy.

In order to collect this information a second companion chart should preferably be constructed. On this chart is carefully set out, again by plotted points, what is known as the "*range variation of samples.*"

It will be apparent that in practically every form of plastic moulding where strict accuracy finish or weight, etc., is required, there must be a limit to the non-uniformity allowable. Naturally, this

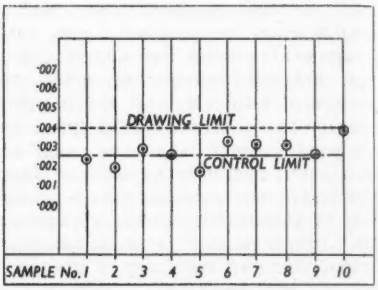

Fig. 5.—A simple range chart compiled from measurement variations of sample groups shown in Fig. 3.

limit will be the most stringent upon those mouldings which have to be maintained dimensionally accurate, and, therefore, if the production moulder is to obtain a true picture of the whole production activity, he must take cognisance of the range of variation over individual components comprising a sample set.

By means of a simple chart (Fig. 5) it is easily possible to determine such a limit. It may also be calculated quite readily beforehand, and is indicated by the drawing of a datum line on the chart beyond which no plotted point should be permitted to occur. The two charts, one for control means and the other for range of variation, are employed in conjunction, because they are so intimately connected. They serve two distinct purposes, however, in setting up effective control.

The control mean chart may be regarded as that needed for setting, since errors indicated thereon are generally associated with departures from the original correct set-up, and, of course, can be corrected by a restoration of that initial condition. Uniformity of the dimensions of the product will be maintained even though errors are denoted on the mean chart, correction of which usually requires only a changing of the average size.

Errors depicted on the range chart, however, are of a rather more serious character, because they indicate unsatisfactory changes in the basic accuracy of the machine or mould operation, or that

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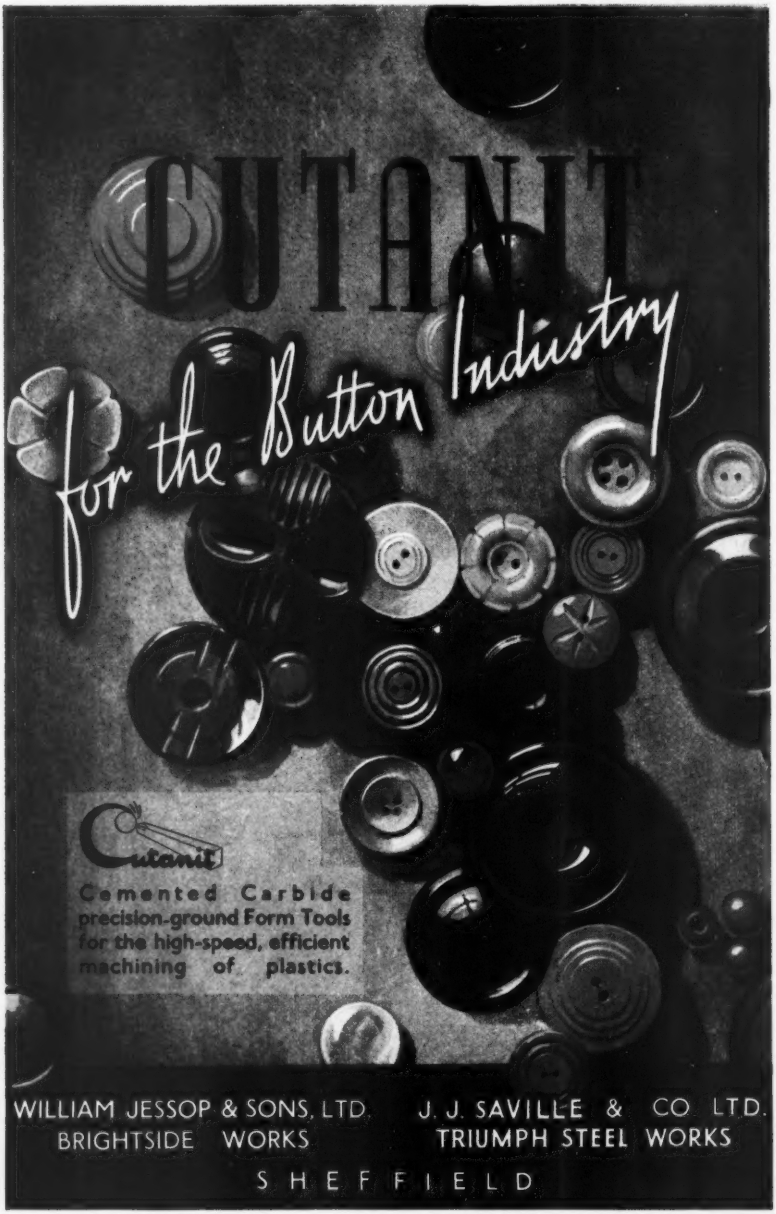
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of an operator, as will be explained. As such, their presence on the range chart calls for immediate and thorough investigation of every phase of moulding activity, in endeavours to locate and eliminate the cause of the trouble.

Of course, if desired, the range chart can be incorporated into the control chart, and in later sections of this series, when illustrations of control of particular moulding processes is given in detail, examples of such combined charts will be illustrated. The degree of variation on the range chart should be well below the drawing tolerances for the job, and also under the calculated control mean, in order to be sure that no single component shall be outside the drawing limits.

Inspection Sampling During Production

One final point worthy of mention relates to the degree of inspection sampling during production from a mould. It is customary under quality control practice to adjust this, so that between 5 per cent. to 10 per cent. of the bulk production in any given interval is inspected. In cases where the drawing limits are extremely fine, or where very high rates of output are obtained, as from a multi-impression tool, it might be advisable to make this proportion as much as 15 per cent.

A query often arises in connection with this. When quality control inspection methods are first introduced into a works, very often one finds the inspector wanting to know what happens to the 90 per cent. or 95 per cent. of components not inspected at all. One is asked how many defective rejects will be found among this portion of the production.

By employing both control and range charts, the latter being compiled at frequent intervals in the same manner as the control chart, a double check is maintained over production. Thus the control chart keeps a strict check over setting variations, and the range chart controls uniformity of the component size.

From very extensive and prolonged use of quality control methods it has been proved that, provided both these charts are kept in control at correct relationships to the stipulated drawing limits set for the job, the strictest confidence can be held of the whole of the output. There is consequently little need to worry about what is happening to the 90 per cent. or more which are not inspected at all, since trends towards departure from the set limits of error will be at once indicated on the charts.

A degree of assurance and knowledge of the whole production operation is thereby derived, which cannot be obtained in any other way, except by a rigid 100 per cent. inspection of every component produced. This, as readers will appreciate, is often impossible or extremely uneconomical in the case of plastic mouldings.

It should be pointed out, however, that when a moulding manufacturer institutes quality control for a short initial period, at any rate, he should always retain 100 per cent. inspection tests as well as the use of control charts. It will thus be possible for him to check out thoroughly the methods of control, and providing his charts are correctly related in the manner described, and, of course, intelligently compiled, a reject will rarely be found even with 100 per cent. inspection. For this reason, therefore, he will be able in time to discard usual inspection methods.

In the next section the author proposes to leave for a time the purely statistical bases of quality control, because enough has now been discussed to make readers familiar with the type of charts used and how they are constructed and applied.

It is often believed that the techniques of quality control cannot be applied successfully to those operations in which the purely human element takes a major share, especially in moulding and such-like activities where the vagaries of human nature are liable to affect the results in such an important manner. As a result of this belief, quality control has been far more readily accepted in the automatic machine shop, but has rarely been afforded a fair try-out in those sections of a works which employ largely hand-operated machines.

(To be continued.)

HEALTH HAZARDS FOR P.V.C. AND ACRYLICS?

(*Continued from page* 85.)

made the easier by the strong antiseptic properties of the monomer. Such plastic masses have been implanted into skull gaps and the skin sewn over them whilst the moulded mass was still comparatively soft. Rapid polymerization takes place under normal conditions inside the body tissues, and during this process some free monomer escapes. There were, however, no general reactions on the part of the patients thus treated.

Adhesive films for surgical use are also made from acrylics. Here there does not seem to be any contra-indication to the use of such films, other than irritable or inflamed skin.

The cellulose plastics were among the first known plastics used as surgical appliances and dental prostheses. They set up a fairly marked irritant reaction, but it must be kept in mind that solvents and plasticizers are apt to create the reaction. The risks, however, are both a general and a local type of reaction, as with rubber solvents and accelerators; the precautions to be taken with regard to dust, fume and gas control are the same and the need for effective barrier creams or emulsions cannot be too strongly emphasized.

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Leaves from a Moulder's Notebook

This is the fifteenth in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. Nos. 1–12 in this series are now available in booklet form and B.I.P. will be pleased to send a copy of this and subsequent notes on request. Comments and enquiries are welcome.

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Direct-core pins of the threaded type and insert-carrying pins of medium diameter ($\frac{1}{4}$ in. to $\frac{3}{4}$ in.) can provide problems of extraction and loading. Flash will creep below the seating of the pin unless the pin is a close fit in its hole in the mould. If the fit is too great in depth, extraction may be somewhat difficult; if on the other hand it is insufficient, flash may creep down and lift the pin from its seating.

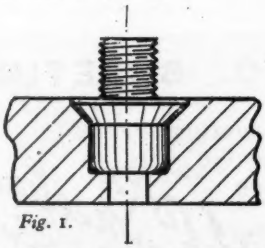

Fig. 1.

Many different types of core pin are used in the moulding industry; each has advantages, which in many cases are outweighed by disadvantages. The valve-seated type (Fig. 1) is popular, but if the parallel shoulder above the angular face is too shallow or too deep its advantages may be lost. For example, it has been found in practice that with a pin having a shoulder diameter of 1 in., the depth of the shoulder must be not less than 5/32 in. in order to prevent the creep of material, and not more than $\frac{1}{4}$ in. to ensure freedom from binding of the pin. (Fig. 2.)

Unfortunately the valve-seated pin is costly to make, because close accuracy of

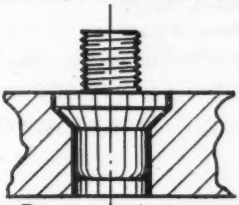

Fig. 2.

diameter and taper seat must be maintained and this calls for grinding operations. To avoid such expense a different type (Fig. 3) has been tested over some

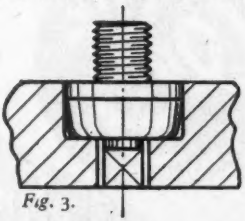

Fig. 3.

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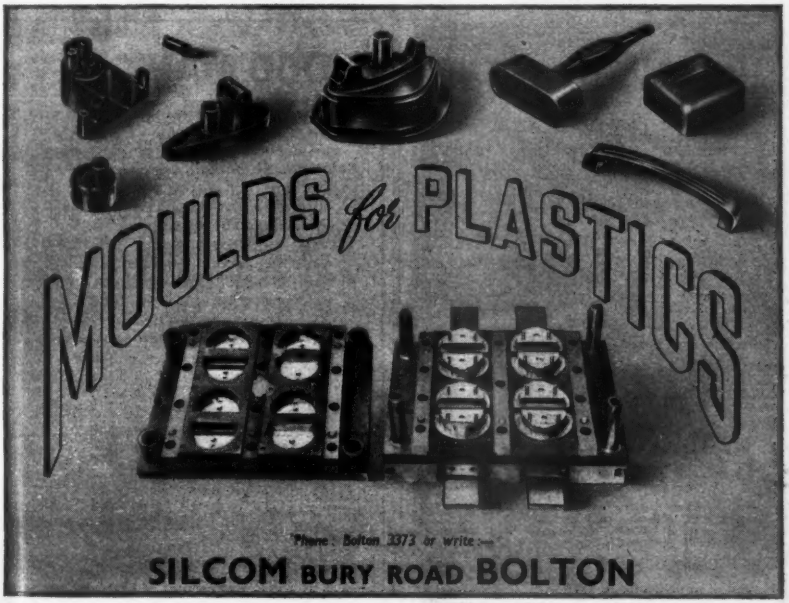

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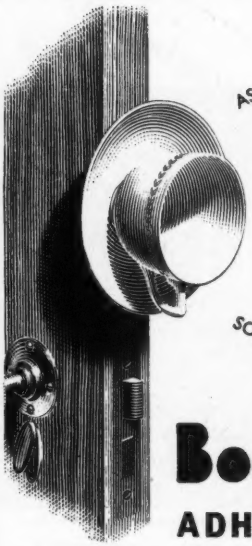

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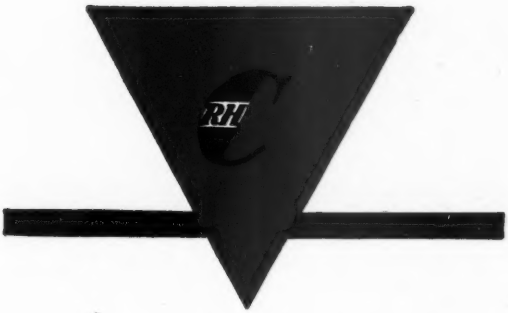

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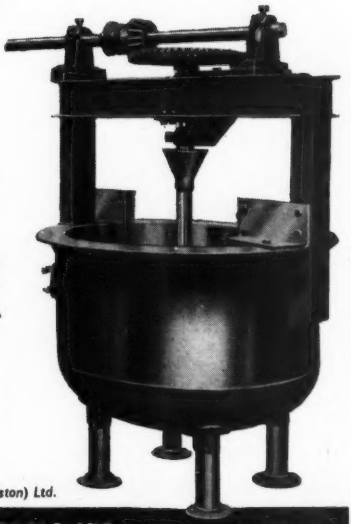

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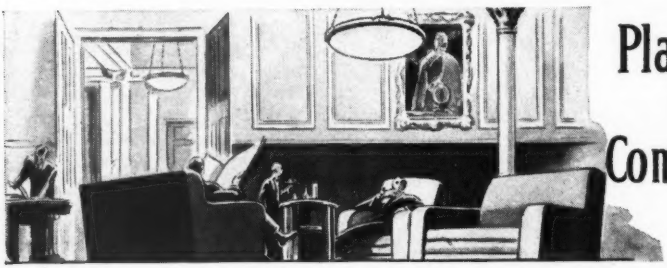

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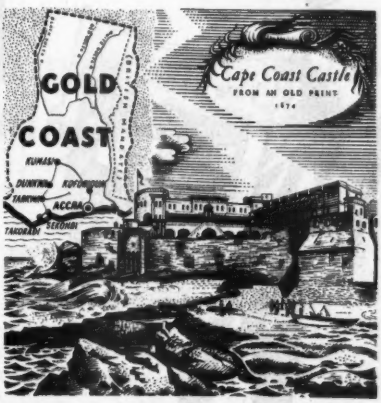

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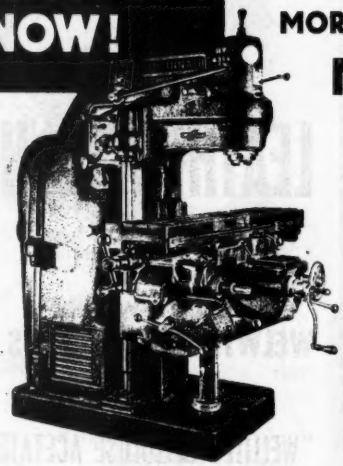

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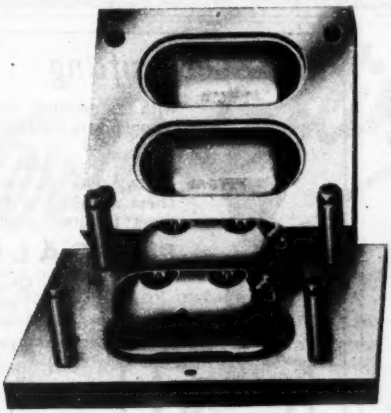

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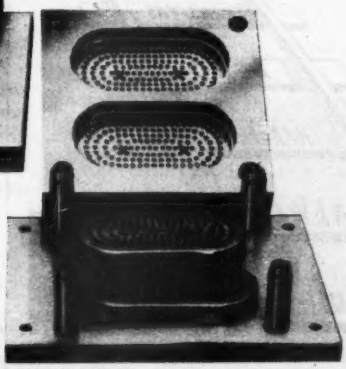

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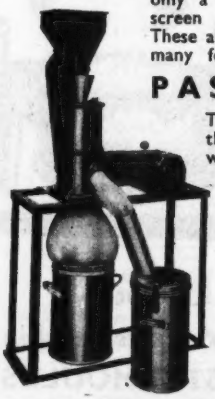

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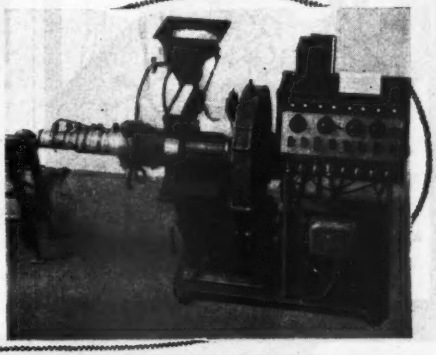

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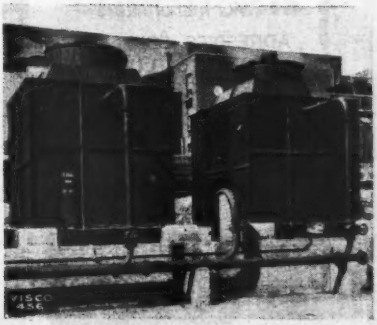

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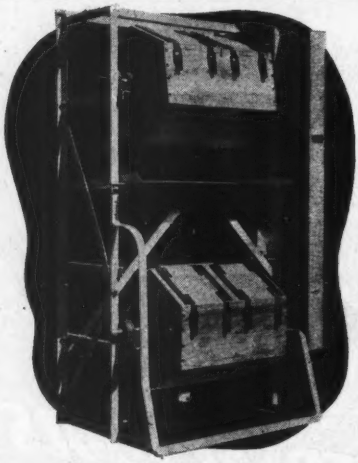

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Phone, Mansion House 1270.
130-5302

Wanted, thermoplastic moulding powders and moulding scraps, all kinds. Offers and samples to Alfa Plastics, Ltd., 20-21 St. Dunstans Hill, E.C.3. 129-4
Perspex, 5/16 in., available for delivery from stock, various sizes. Ashdowns, Ltd., Eccleston Works, St. Helens. 129-13
P.V.C. sheets, 55 ins. by 24 ins., 50 thou. thick, embossed and plain surfaces, all colours in stock. Inquiries also invited for P.V.C. and N/C coated fabrics.
Felbo and Co., Ltd., 119 Regent Street, London, W.1. Regent 6639. 129-15
Cellulose acetate urgently required, white, matt finish, 20/1000 in., 30/1000 in., 40/1000 in. Box 2300, care of "Plastics." 129-16
Old-established manufacturers require quantities of di-octyl phthalate. Please write Box 2307, care of "Plastics." 129-18
Offers wanted for Neoprene cement, tropical, 836 1-gallon tins, primer 520 1-pint tins, Neoprene cement, Continental, 389 1-gallon tins. Further particulars from Box 2311, care of "Plastics," or Euston 4804. 129-20
Wanted, Perspex offcuts, ⅛-in. material, clear, coloured, must be paper covered, minimum widths 1 in., lengths 12 ins., or fair-sized pieces. Universal, 96 Grove Vale, East Dulwich, S.E.22. New Cross 3134. 129-x4589

LARGE STOCKS HELD OF
ACETATE SHEETING,
TRANSPARENT AND COLOURS.
ALSO PRINTED DESIGNS, LACE, FLORAL, NURSERY AND EXCLUSIVE PATTERNS.
Suitable for Lampshade Trade, etc.
ALLANS,
37 FARRINGDON STREET, LONDON, E.C.4.
Call if possible 9 to 6. Closed Saturdays.
134-5309

Perspex for sale, new sheets, offcuts, large and small scrap, powders; clear and colours. Box 9024, care of "Plastics." 131-5305
Moulding powders. If you have any redundant stocks for disposal contact us and also give us your inquiries if you are in need of supplies of other powders. Box 9756, care of "Plastics." 131-5304
Substantial buyer wanted for 10 to 40 tons polythene plastic sheets and pieces. Flexible translucent material, mostly coloured. Figured, embossed, etc., and of small but useful sizes. W. Pattison, 200 Siddals Road, Derby. 129-x4128
Body for ceramics, floorings, modelling, refractories, etc. Suppliers, Dohm, Ltd., 167 Victoria Street, London, S.W.1. 133-4969
Black cellulose acetate, 52 ins. by 24 ins. by .06 in. thick, 2,000 sheets available, semi-polished, first-class condition. Specification DTD 315. Immediate delivery. Box PP 14552, Samson Clarks, 57-61 Mortimer Street, W.1. 130-5307

Raw Material Available and Wanted (contd.)

Perspex I.C.I. acrylic sheeting. Official stockists offer services which include cutting to size, edge polishing and tinting; also Crinothene for lampshades, handbags, etc. Stock and price lists from Almex, Ltd., 78 Exchange Buildings, Birmingham, 2. 139-4971

MOON AIRCRAFT, LTD.,
SPECIALISTS IN MANIPULATED AND FABRICATED WORK.
OFFICIAL I.C.I. STOCKISTS FOR PERSPEX.
Have available from stock all thicknesses in clear and colour flat sheet cut to customers' sizes.
Inquiries, prices and particulars upon application to
CLIFT WORKS, BOX, WILTS,
Phone, Box 188.
London Office:
GROSVENOR GARDENS HOUSE, S.W.1.
Phone, Victoria 9182-3.
132-4266

Connection wanted directly with consumer of wood meal. Reply to Swedish factory of wood meal, Gumaelius Advertising Agency, Stockholm, Sweden. 129-27
Large quantities of clean polythene, white, black and other colours, segregated. Box 2028, care of "Plastics." zzz-202

Always large stocks of
CASEIN
rods, tubes and sheets
PERSPEX
sheets up to 1 in. thick.
CELLULOSE ACETATE.
S. Rosenfeld.
93, Aldersgate Street, E.C.1.
Phone, Clerkenwell 4686. 132-4019

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. 139-4965
For sale, P.V.C. scrap. Offers invited. Box 8494, care of "Plastics." zzz-426
Cellulose acetate scrap urgently required; best prices paid. Write Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. Phone, Metro 9641-5. zzz-424
500 Sheets clear 60/000 Plastics, British Celanese Cellustoid for disposal, as new, interleaved with tissue. Astral Aero Model Co., Dixon Lane Road, Lower Wortley, Leeds, 12. 129-x2855
Perspex and Crinothene, official I.C.I. stockists for North-West area, invite inquiries for flat sheet Perspex, clear and coloured, from 1/16th-in. to ½-in. thickness; also official I.C.I. stockists of Crinothene. Plastics (Manchester), Ltd., 11 Whitworth Street, Manchester, 1. Phones, Central 0272 and 1725. zzz-447
Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-410
We are now able to supply an adhesive suitable for cementing the Perspex which we supply. Inquiries to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-429
For sale, 15 tons P.V.C. black compound (recovered); samples available. Write to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-428
Regular supplies of imported phenolic and urea powders, polystyrene and cellulose acetate injection powders. Inquiries, Box 1211, care of "Plastics." zzz-454
Regular supplies of imported celluloid and cellulose acetate sheets, tubes and rods. Inquiries, Box 1212, care of "Plastics." zzz-455
Perspex sheet, clear and coloured, 1/16 in. to ⅝ in. available. Box M.T., Wydell's Advertising Service, 84 St. Paul's Churchyard, London, E.C.4. 129-4265
Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-457
P.V.C. strippings from cables, thoroughly cleaned, black, brown, red, yellow, blue, etc. Segregated. Large quantities, 1s. 3d. lb.
John Walton and Co. (Castleside), Ltd., Metalex Works, Gt. Cambridge Road, Enfield. Phone, Enfield 3425. zzz-458
For sale, surplus to requirements, approx. 800 lb. virgin cellulose acetate moulding powder, colour red, 3s. 9d. lb. Apply, Box 1551, care of "Plastics." 129-4018

Raw Material Available and Wanted (contd.)

Acetate cellulose sheeting wanted to purchase for cash, transparent or coloured up to 30 thou. thick, any size or quantity, send samples with details. Allans, 37 Farringdon Street, London, E.C.4. 132-4013

Transparent packaging of all types; lipstick refill containers, ex stock. Modern Plastics, Ltd., Kangley Bridge Road, S.E.26. 131-5303

For sale constantly, cut-offs of 1/8-in. and 1/16-in. natural Holoplast, from 1s. per pound, according to size of pieces. Larks Spraying Process, Monument Hill, Weybridge. 129-33

Plastic boards, 1-16-in., specially treated, highest artistic finish; suitable for panelling, furniture, bath, splashbacks, etc.; plain colours or marble effect, and wood (oak, mahogany, walnut, etc.), sheets 8 by 4 cut to requirements. Prompt deliveries. Larks Spraying Process, Monument Hill, Weybridge. 129-32

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 2382, care of "Plastics." zzz-468

D. H. Ridout and Son, Ltd., Reg. Office 12 Stedman Road, Southbourne, Bournemouth. Phone, Southbourne 505, offer:

Perspex scrap, crystal and amber, all gauges, good sized pieces, 1s. 3d. to 2s. lb., according to gauge, size and quantity required.

Ribbed plastic belting, 1¾ ins. wide, green and beige, 6d. per yard.

Plastic panelling in sheets 96 ins. by 48 ins. by 1/16 in. or ⅛ in., suitable for caravans or partitions, from 45s. sheet.

Transparent acetate sheeting, .007 in. thick, 3s. 6d. lb.

Opaque tangerine acetate sheets, 48 ins. by 21 ins. by 1/16 in., new material paper-interleaved, 25s. sheet.

Clear emerald acetate sheeting, 50 ins. by 20 ins. by ⅛ in., new material paper-interleaved, 35s. sheet.

Plastic door furniture, complete with locks, at keen prices.

2-mm. interleaved crystal acetate sheets, new, slightly curved, 4s. 6d. lb.

Numerous crystal and amber acetate discs, suitable for pocket torches, toys, etc., all new material, 4s. lb.

Samples on request. 129-29

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Plastics manufacturers (Home Counties) require two physical chemists, fresh graduates acceptable but good degrees essential; for one senior position Ph.D. standard preferred. Salary up to £1,000 p.a. Progressive positions, modern laboratory. Applicants should give all usual particulars in strict confidence. Box 1912, care of "Plastics." 129-4966

A graduate organic chemist, age 25-35 years, with research experience on phenolic plastics and with good knowledge of physical chemistry, required by Yorkshire chemical manufacturers for research work on a range of products closely allied to those of the plastics industry. Salary according to age and qualifications, also superannuation scheme in operation. Replies to Box 2027, care of "Plastics." 129-4969

Well-established thermoplastic raw material manufacturing concern requires the services of representatives in London and the Home Counties. A good working knowledge of applications of plastic materials is required, age 22-30 years, good education, at least matriculation standard, B.Sc. preferred. Write, giving full details, to Box 2431, care of "Plastics." 129-37

Large plastic-manufacturing organization requires the services of a manager to control and promote the sales of P.V.C., thorough commercial and technical knowledge of the product required, age 27-35, B.Sc. preferred. Write, giving full details, to Box 2432, care of "Plastics." 129-36

Tool designers required by West London firm of engineers with specialized experience on Bakelite mould design. Please apply, stating details of experience, when available, and salary required to Box 2298, care of "Plastics." 129-6

Skilled man with practical experience in fabrication of plastics (preferably with knowledge of plastic chemistry) offered position with manufacturers in Sussex, with view to rapid promotion to foreman. Write, stating age, salary required, qualifications, experience, to Box 2306, care of "Plastics." 129-8

Required immediately for really progressive position, chemist, to develop and supervise research work in connection with new plastic process. Applicant must be prepared to devote his entire energy to the new project and be capable of developing initiative and resource. Some travelling may be involved later. Apply, stating age, salary and experience, to Box 531, care of Granthams, Advertising Agents, Reading. 129-11

Situations Vacant (contd.)

Research chemist required for plastics industry, preferably B.Sc., with Hons. chemistry; industrial experience an advantage. Write, stating age, full details and salary required, to Box 2314, care of "Plastics." 129-7

Unqualified chemist or technologist aged 21-30 years, preferably with knowledge of elementary chemistry and plastics technology and with mechanical aptitude required for control and development work in a small factory, London, S.W.1. Commencing salary £300 p.a., or upwards according to experience. Box 2303, care of "Plastics." 129-9

Energetic young man required, with commercial experience of plastics, especially injection moulding, who will have to be in contact with customers and must work on his own initiative. This is a permanent progressive position, and the salary will be in accordance with qualifications. Apply, giving all details, in first instance to Box 2026, care of "Plastics." 129-10

Bakelite, Ltd., require for their Research and Development Department an experienced organic chemist, preferably less than 30 years of age, for work in connection with vinyl-type resins. Sound fundamental knowledge is essential, but keenness and enthusiasm will rank equally with academic distinctions. Ability to translate work from bench to pilot plant of prime importance. Applications should be addressed to Director, Research and Development Department, Bakelite, Ltd., Redfern Road Works, Tyseley, Birmingham, 11. 129-12

Old-established firm of plastic moulders, West London district, have vacancy for representative; preference given to applicant with some engineering knowledge; salary generous, in accordance with ability; position permanent. Apply, Box 2381, care of "Plastics." 129-28

SITUATIONS WANTED

Works or general manager, highly qualified in factory organization, administration, production control, costing, desires suitable executive position: present manager of large moulding company; free now. Box 2067, care of "Plastics." 129-x4056

Keen, energetic man (24), ex-public school, exempt Control of Engagement Order, six months' training in Plastics industry, seeks change; anxious to undergo further training, provided good prospects offered. Box 2266, care of "Plastics." 129-x4590

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 137-3686

WANTED

Film spools for roll films required in 50,000 lots; also hire of moulding tools. S.L.P.P., 28 Upper Green East, Mitcham. Phone, Mitcham 4296. 131-x4912

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Use a Trade Mark. Consult
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12 Church Street, Liverpool. 130-9745

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 129-9541

Huts. Nissen type, 36 ft. by 16 ft. and other sizes; also other industrial buildings suitable for workshops, canteens, site offices, clubs, etc. No licence required. Write, phone or call (open Saturday afternoons). J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-430

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. zzz-436

Calendars, 21-piece perpetual-figure sets, celluloid, for all ornamental calendars.
Tickets and Co., Silver Street, Leicester. 129-3734

Packing Cases for Export, etc. Full service, prompt deliveries. F. Rawle and Co., Ltd., 71 Kensington Avenue, London, E.12. Phone, Grangewood 2003. 132-4010

One-gallon round tins, new, five-gallon square lever lid tins, new, and bottles for all purposes. Inquiries Box 1899, care of "Plastics." 130-x3589

For sale, bottles, tins, drums, barrels and containers of all descriptions. If you have any difficulty with your container supplies contact Box 1841, care of "Plastics." 130-x3472

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 134-5313

Plastics Industry Notebook, valuable data, 1s. 3d., post free. H. O. Quinn, Ltd., 151 Fleet Street, E.C.4. (Phone, Central 8194). 129-x4127

Perspex sheets, 3 ft. by 3 ft. by 1 ft. 6 ins., green, blue, yellow, cream. Blackpool Plasmet Crafts, Ltd., Clare Street, Blackpool. 964-4811

Plastic cement for use with Perspex Acrylic sheets. Grade I, available in large or small quantities, clear and coloured. Trade inquiries from Evolite Plastics, Ltd., 325 Latimer Road, London, W.10. Phone, Lad 1879. 138-04011

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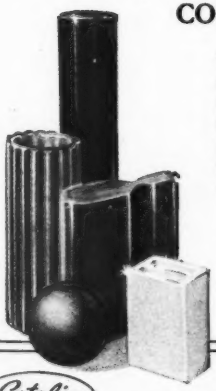
COLOUR... *The Field of the Cloth of Gold*



The blaze of flying pennants, the glint of armour, the gold and crimson trappings... all the colourful beauty that was this proud spectacle is recaptured in Catalin. For Catalin is a thermosetting cast phenolic resin possessing a wide range of glorious deep-grained colours, shades and mottles. It is the material that gives new charm, grace and glamour to the most everyday articles and inspires the wonders of the future.

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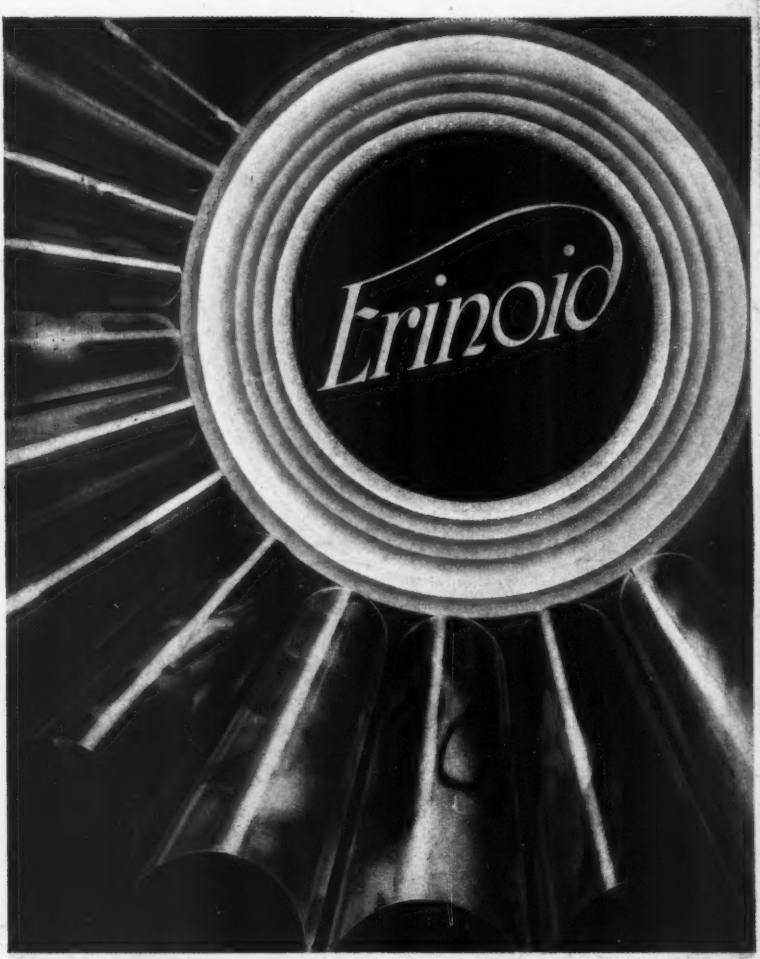

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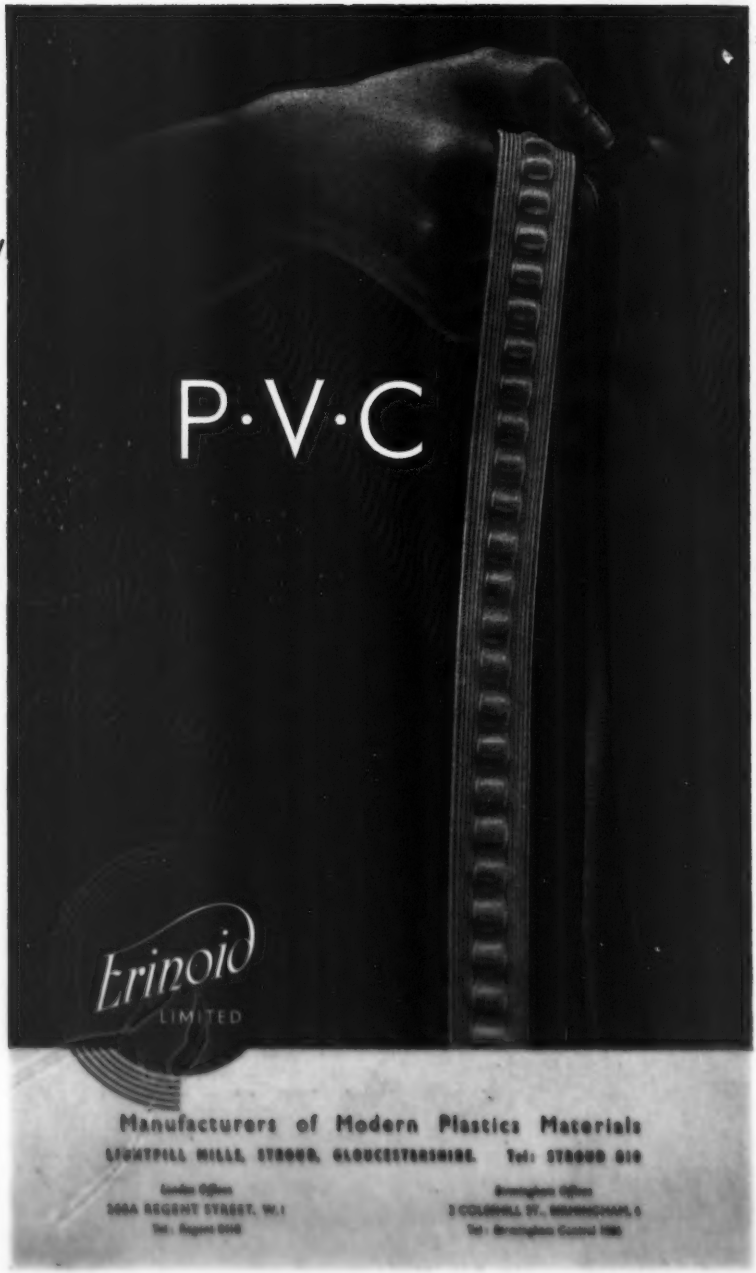
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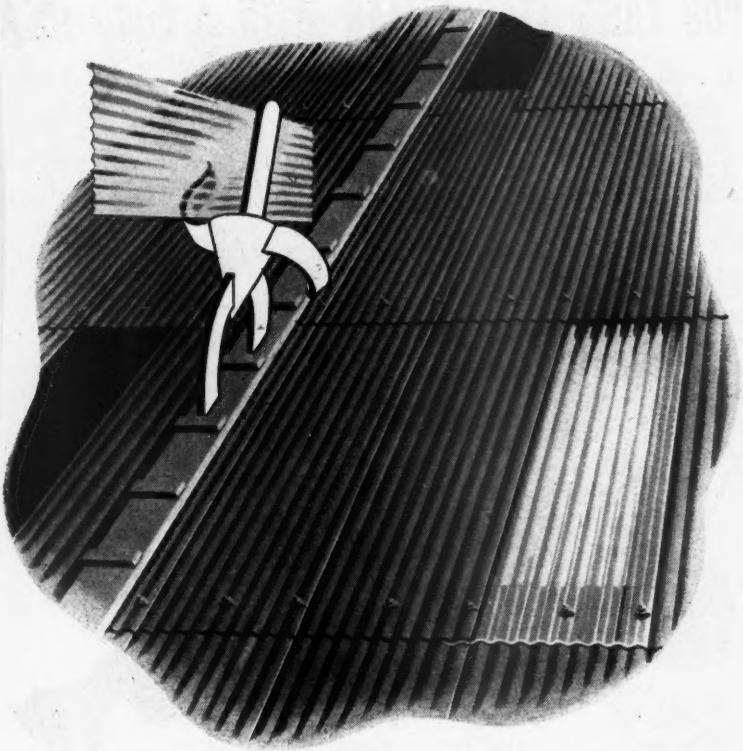

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Plastics from I.C.I. offer their contribution to industrial welfare. Corrugated "Perspex" acrylic sheet, which can be fixed as easily as normal corrugated sheet, makes possible the planned lighting of factory interiors.

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